NFPA 1992
Standard on Liquid Splash-Protective Ensembles and Clothing for Hazardous Materials Emergencies

2000 Edition

National Fire Protection Association, 1 Batterymarch Park, PO Box 9101, Quincy, MA 02269-9101
An International Codes and Standards Organization

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NFPA 1992

Standard on

Liquid Splash-Protective Ensembles and Clothing for Hazardous Materials Emergencies

2000 Edition

This edition of NFPA 1992, *Standard on Liquid Splash-Protective Ensembles and Clothing for Hazardous Materials Emergencies*, was prepared by the Technical Committee on Hazardous Materials Protective Clothing and Equipment, released by the Technical Correlating Committee on Fire and Emergency Services Protective Clothing and Equipment, and acted on by the National Fire Protection Association, Inc., at its November Meeting held November 14–17, 1999, in New Orleans, LA. It was issued by the Standards Council on January 14, 2000, with an effective date of February 11, 2000, and supersedes all previous editions.

This edition of NFPA 1992 was approved as an American National Standard on February 11, 2000.

Origin and Development of NFPA 1992

In 1985, the National Transportation Safety Board (NTSB) issued report I-004-5 on a hazardous material incident that occurred in Benicia, California. In that report, the NTSB recommended that standards be developed for protective clothing for protection from hazardous chemicals. The United States Department of Transportation (DOT) issued a position that requested private sector standards development to undertake the project of writing the standards on hazardous chemical protective clothing and asked other governmental agencies to assist and participate in the private sector standards development system. DOT at this time also directly requested that the NFPA develop documents on hazardous chemical protective clothing. The Environmental Protection Agency (EPA), the United States Coast Guard (USCG), the Federal Emergency Management Agency (FEMA), and the Occupational Safety and Health Administration (OSHA) either adopted position statements modeled after the DOT position or endorsed the DOT position.

During 1985, the NFPA Standards Council approved a project for development of these standards and assigned the project to the Technical Committee on Fire Service Protective Clothing and Equipment. The Technical Committee on Fire Service Protective Clothing and Equipment established a standing Subcommittee on Hazardous Chemicals Protective Clothing, and they began their work in Phoenix, Arizona, in March 1986. Representatives from the USCG, FEMA, and OSHA participated on the subcommittee.

At the same time, ASTM was developing a document on a selection of chemicals for evaluating protective clothing materials that would serve as one of several ASTM testing criteria that would be referenced in the NFPA standards.

The subcommittee met several times over a $2\ ^1/_2$-year period at different locations across the country and developed two standards, one for vapor-protective protection and one for liquid splash-protective protection.

NFPA 1991 addresses vapor-protective ensembles designed to protect emergency response personnel against exposure to specified chemicals in vapor and liquid splash environments during hazardous materials emergencies. Chemical permeation resistance documentation is required for primary suit materials (garment, visor, gloves, and boots) against each chemical in the NFPA battery of chemicals and any additional chemicals or specific chemical mixtures for which the manufacturer is certifying the suit. The NFPA battery of chemicals consists of 21 chemicals: those specified in ASTM F 1001, *Standard Guide for Chemicals to Evaluate Protective Clothing Materials*. These chemicals were selected because they are representative of the classes of chemicals that are encountered during hazardous chemical emergencies.

The standard includes performance requirements that were established to reflect simulated use conditions. A suit pressurization test is used to check the airtight integrity of each protective suit. Also, an overall suit water penetration test is designed to ensure the suit provides full body protection against liquid splashes. Primary suit materials must resist permeation for one hour or more by each chemical in the NFPA battery. Manufacturers may certify protective suits for additional chemicals when the same permeation performance is met. Also

included are penetration resistance testing of closures, and leak and cracking pressure tests for exhaust valves. These tests allow determination of adequate suit component performance in hazardous chemical environments.

Material testing for burst strength, tear strength, abrasion resistance, flammability resistance, cold temperature performance, and flexural fatigue are required so that materials used for vapor-protective suits will afford adequate protection in the environment where they will be used.

NFPA 1992 addresses liquid splash-protective ensembles and clothing designed to protect emergency response personnel against exposure to specified chemicals in liquid splash environments during hazardous materials emergencies. Chemical penetration resistance documentation of garment material against an NFPA battery of test chemicals and any additional chemicals or specific chemical mixtures for which the manufacturer is certifying the suit is required. The NFPA battery of chemicals were selected from ASTM F l00l, *Standard Guide for Chemicals to Evaluate Protective Clothing Materials*. These do not include liquid chemicals with known or suspected carcinogenicity or skin toxicity because these garments deal with skin exposure and not inhalation. This criterion produces a different subset of ASTM F l00l chemicals to be certified.

The standard includes performance requirements that were established to reflect simulated use conditions. An overall suit water penetration test is included to ensure the suit provides full body splash protection. Materials testing includes burst strength, tear resistance, flammability resistance testing, abrasion resistance, cold temperature performance, and flexural fatigue testing. These tests are required so that garment materials will provide adequate protection in the environment in which they will be used.

The first edition of NFPA 1992 was voted on by the Association at the 1989 Fall Meeting in Seattle, Washington, on November 15, 1989, and had an effective date of February 5, 1990.

The Subcommittee on Hazardous Chemicals Protective Clothing began an early revision (4-year cycle) of the 1990 edition of NFPA 1992 in December 1991. During 1993, the NFPA restructured the manner in which committees were organized, and all standing subcommittees were eliminated. Within the Technical Committee on Fire Service Protective Clothing and Equipment, the former standing subcommittees were reorganized as task groups to address specific technical issues, and the technical committee assumed the entire responsibility for NFPA 1992.

The second edition of NFPA 1992 encompassed revised scope and purpose sections to include optional components for enhanced protection and replacement items. Test methods were updated and refined to better ensure repeatability of testing results. Extensive changes were made to the product labels to better accommodate the optional and replacement items.

The second edition was acted on by the membership of the Association at the NFPA Annual Meeting in San Francisco, California, on May 18, 1994, and was issued with an effective date of August 5, 1994.

Since the second edition, the entire project for fire service protective clothing and equipment was reorganized, in January 1995, by the Standards Council. The new project has a Technical Correlating Committee on Fire and Emergency Services Protective Clothing and Equipment and seven technical committees operating within the project. The former standing Subcommittee on Hazardous Chemicals Protective Clothing was established as the new Technical Committee on Hazardous Materials Protective Clothing and Equipment and has the responsibility for NFPA 1992.

This third edition, with the new title of *Standard on Liquid Splash-Protective Ensembles and Clothing for Hazardous Materials Emergencies,* represents a complete revision to the second edition and addresses the protection as an ensemble in addition to individual items of protective clothing. It also combines certain requirements for liquid-splash protection for support function activities from the former NFPA 1993, *Standard on Support Function Protective Clothing for Hazardous Chemical Operations,* the 1994 edition, which was withdrawn on January 14, 2000. Protective clothing certified as compliant with NFPA 1993 was seldom used by hazardous materials incident responders. More practical requirements for liquid splash-protective ensembles and clothing used for response and support activities are included in this edition of NFPA 1992. The objective is to offer more choices and flexibility for purchasers to obtain protective ensembles or clothing that will better address their operational needs.

This third edition was presented to the Association membership at the 1999 November Meeting in New Orleans, Louisiana, on November 17, 1999, and issued by the Standards Council with an effective date of February 11, 2000.

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NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on the design, performance, testing, and certification of protective clothing and protective equipment manufactured for fire and emergency services organizations and personnel, to protect against exposures encountered during emergency incident operations. This Committee shall also have the primary responsibility for documents on the selection, care, and maintenance of such protective clothing and protective equipment by fire and emergency services organizations and personnel.

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Committee Scope: This Committee shall have primary responsibility for documents on protective clothing and protective equipment, except respiratory protective equipment, that provides hand, foot, torso, limb, and head protection for fire fighters and other emergency services responders during incidents that involve hazardous materials operations. These operations involve the activities of rescue; hazardous material confinement, containment, and mitigation; and property conservation where exposure to substances that present an unusual danger to responders are present or could occur due to toxicity, chemical reactivity, decomposition, corrosiveness, or similar reactions.

Additionally, this committee shall have primary responsibility for documents on the selection, care, and maintenance of hazardous materials protective clothing and protective equipment by fire and emergency services organizations and personnel.

Contents

NFPA 1992

Standard on

Liquid Splash-Protective Ensembles and Clothing for Hazardous Materials Emergencies

2000 Edition

NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Appendix A.

Information on referenced publications can be found in Chapter 7 and Appendix B.

Chapter 1 Administration

1-1 Scope.

1-1.1* This standard shall specify minimum design, performance, certification, and documentation requirements; test methods for liquid splash-protective ensembles and liquid splash-protective clothing; and additional optional criteria for chemical flash fire protection.

1-1.2 This standard shall apply to the design, manufacturing, and certification of new liquid splash-protective ensembles or new liquid splash-protective clothing items. This edition of this standard shall not apply to liquid splash-protective ensembles or liquid splash-protective clothing items manufactured to previous editions of NFPA 1992, *Standard on Liquid Splash-Protective Suits for Hazardous Chemical Emergencies* (former title).

1-1.3 This standard shall not apply to protection from chemical or biological warfare agents or from chemical or biological terrorism incidents. Such protection shall be provided by vapor-protective ensembles that are also compliant with the additional optional criteria for chemical and biological terrorism vapor-protective ensembles as specified in NFPA 1991, *Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies.*

1-1.4* This standard shall not apply to protective ensembles or clothing for hazardous materials emergencies involving known or suspected carcinogens, hazardous materials with known skin toxicity, or hazardous material vapor atmospheres.

1-1.5 This standard shall not apply to protective ensembles or clothing for *any* fire-fighting applications and shall not provide criteria for protection from radiological, biological, liquefied gas, or cryogenic liquid hazards, or against explosive vapor atmospheres.

1-1.6 This standard shall not apply to the respiratory protection that is necessary for proper protection with the protective ensemble or clothing.

1-1.7 This standard shall not apply to use requirements for liquid splash-protective clothing or protective ensembles as these requirements are specified in NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program.*

1-1.8 Certification of the liquid splash-protective ensembles and liquid splash-protective ensemble clothing items as compliant with the requirements of this standard shall not preclude certification to additional appropriate standards where the protective clothing meets all the applicable requirements of each standard.

1-1.9 The requirements of this standard shall not apply to accessories that might be attached to any element of the liquid splash-protective ensemble, or individual liquid splash-protective clothing items, unless specifically addressed herein.

1-1.10 Nothing herein shall restrict any jurisdiction or manufacturer from exceeding these minimum requirements.

1-2 Purpose.

1-2.1 The purpose of this standard shall be to establish a minimum level of protection for emergency services personnel against adverse liquid splash and particulate environments during hazardous materials incidents.

1-2.2 The purpose of this standard shall also be to establish a minimum level of limited chemical flash fire protection, for escape only in the event of a chemical flash fire, as an option for compliant liquid splash-protective ensembles or liquid splash-protective clothing items. The purpose of this option shall be to allow users with the flexibility to choose a combination of features that match the anticipated exposure and expected needs.

1-2.3* Controlled laboratory tests used to determine compliance with the performance requirements of this standard shall not be deemed as establishing performance levels for all situations to which personnel can be exposed.

1-2.4 This standard is not intended to be utilized as a detailed manufacturing or purchase specification but shall be permitted to be referenced in purchase specifications as minimum requirements.

1-3 Definitions.

1-3.1 Accessories. Those items that are attached to a liquid splash-protective ensemble that are not necessary to meet the requirements of this standard. Such accessories include, but are not limited to, harnesses, cooling systems, and communications devices.

1-3.2 Afterflame Time. The length of time for which a material, component, or chemical protective suit continues to burn after the simulated chemical flash fire has ended.

1-3.3* **Approved.** Acceptable to the authority having jurisdiction.

1-3.4* **Authority Having Jurisdiction.** The organization, office, or individual responsible for approving equipment, materials, an installation, or a procedure.

1-3.5 Biological Agents. Biological materials that are capable of causing disease or long-term damage to the human body.

1-3.6 Boot. See definition 1-3.43, Liquid Splash-Protective Footwear.

1-3.7 Bootie. A sock-like extension of the garment leg designed to protect the wearer's feet when worn in conjunction with an outer boot.

1-3.8 Care. Procedures for cleaning, decontamination, and storage of liquid splash-protective ensembles and clothing.

1-3.9 Certification/Certified. A system whereby a certification organization determines that a manufacturer has demonstrated the ability to produce a product that complies with the requirements of this standard, authorizes the manufacturer to

use a label on listed products that comply with the requirements of this standard, and establishes a follow-up program conducted by the certification organization as a check on the methods the manufacturer uses to determine compliances with the requirements of this standard.

1-3.10 Certification Organization. An independent, third party organization that determines product compliance with the requirements of this standard with a labeling/listing/follow-up program.

1-3.11 Chemical and Biological Terrorism Incidents. Situations involving the release of chemical or biological warfare agents in civilian areas by terrorists.

1-3.12* Chemical Flash Fire. The ignition of a flammable and ignitible vapor or gas that produces an outward expanding flame front, as those vapors or gases burn. This burning and expanding flame front (fireball) will produce both thermal and kinetic energy to the environment.

1-3.13 Chemical Protection Layer. The layer or layers included in the composite that are intended to provide penetration resistance against chemicals and to provide liquidtight integrity for the protective ensemble or clothing.

1-3.14 Chemical-Protective Material. Any material or composite used in liquid splash-protective ensemble or clothing for the purpose of providing protection from chemical hazards; can be a part of the "primary suit material."

1-3.15 Clothing Items. See the definition 1-3.59, Protective Clothing Items.

1-3.16 Compliance/Compliant. Meeting or exceeding all applicable requirements of this standard.

1-3.17 Component. Gloves or footwear used in the construction of the liquid splash-protective ensemble.

1-3.18 Component Part(s). Any material(s) or part(s) used in the construction of a liquid splash-protective ensemble or clothing.

1-3.19 Composite. Any layering of chemical-protective materials or components as they appear in the final liquid splash-protective ensemble or clothing construction.

1-3.20 Cryogenic Gas. A refrigerated liquid gas having a boiling point below –130°F (–90°C) at atmospheric pressure.

1-3.21 Elements. The parts or items that comprise the protective ensemble. The protective ensemble elements are garments, gloves, and footwear, and encapsulating ensembles include a hood.

1-3.22 Emergency Response Personnel. Personnel assigned to organizations that have the responsibility for responding to hazardous materials emergencies.

1-3.23 Encapsulating. A type of liquid splash-protective ensemble that provides liquidtight protection, but does not provide vaportight or gastight protection. *(See also definitions 1-3.42, Liquid Splash-Protective Ensemble; 1-3.24, Encapsulating Ensemble; and 1-3.51, Nonencapsulating Ensemble.)*

1-3.24 Encapsulating Ensemble. The elements of the encapsulating liquid splash-protective ensemble are garments, hoods, gloves, and footwear that provide protection to the upper and lower torso, head, hands, and feet and completely cover the wearer and the wearer's SCBA or supplied air respirator. The encapsulating liquid splash-protective ensemble provides liquidtight protection. *(See also definitions 1-3.23, Encapsulating and 1-3.50, Nonencapsulating.)*

1-3.25 Ensemble. See definition 1-3.42, Liquid Splash-Protective Ensemble.

1-3.26 External Fittings. Any fitting externally located on, and part of, the liquid splash-protective ensemble that is not part of the garment material, visor material, gloves, footwear, seams, or closure assembly. Airline, cooling device, and communications system connections or pass-throughs, and glove and boot interface materials on the chemical protective suit are examples of external fittings.

1-3.27 Flammable or Explosive Atmospheres. Atmospheres containing chemical vapors or gases at concentrations that will burn or explode if ignited.

1-3.28 Follow-Up Program. The sampling, inspections, tests, or other measures conducted by the certification organization on a periodic basis to determine the continued compliance of products listed that are being produced by the manufacturer to the requirements of this standard.

1-3.29 Footwear. See definition 1-3.43, Liquid Splash-Protective Footwear.

1-3.30 Footwear Upper. That portion of the footwear above the sole.

1-3.31 Garment. See definition 1-3.44, Liquid Splash-Protective Garment.

1-3.32 Garment Closure. The suit component designed and configured to allow the wearer to enter (don) and exit (doff) the liquid splash-protective suit.

1-3.33 Garment Closure Assembly. The combination of the suit closure and the seam attaching the suit closure to the garment, including any protective flap or cover.

1-3.34 Garment Material. The principal chemical-protective material used in the construction of the liquid splash-protective suit.

1-3.35 Glove. See definition 1-3.45, Liquid Splash-Protective Glove.

1-3.36 Hazardous Materials. Any solid, liquid, gas, or mixture thereof that can potentially cause harm to the human body through respiration, ingestion, skin absorption, or contact.

1-3.37 Hazardous Materials Emergencies. Incidents involving the release or potential release of hazardous materials into the environment that can cause loss of life, personnel injury, or damage to property and the environment.

1-3.38 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

1-3.39 Ladder Shank. Reinforcement to the shank area of protective footwear designed to provide additional support to the instep when standing on a ladder rung.

1-3.40* Liquefied Gas. A gas that, under its charged pressure, is partially liquid at 21°C (70°F).

1-3.41 Liquid Splash-Protective Clothing. Clothing items designed to provide a degree of protection for emergency response personnel from adverse exposure to the inherent risks of liquid-chemical exposure occurring during hazardous materials emergencies and similar operations. The clothing items are garments, gloves, and footwear. The liquid splash-

protective clothing items are not considered a "ensemble." *(See also definition 1-3.42, Liquid Splash-Protective Ensemble.)*

1-3.42 Liquid Splash-Protective Ensemble. Multiple elements designed to provide a degree of protection for emergency response personnel from adverse exposure to the inherent risks of liquid-chemical exposure occurring during hazardous materials emergencies and similar operations. The liquid splash-protective ensemble is either an encapsulating or nonencapsulating ensemble.

1-3.43 Liquid Splash-Protective Footwear. An item of clothing or an element of the protective ensemble designed to provide minimum protection to the foot, ankle, and lower leg. Footwear includes boots or outer boots in conjunction with booties.

1-3.44 Liquid Splash-Protective Garment. An element of the liquid splash-protective ensemble or an item of protective clothing designed to provide protection to the upper and lower torso, arms and legs, excluding the head, hands, and feet when garment hoods, gloves, and footwear are not provided. Garments include one or multi-piece splash suits, coveralls, and encapsulating suits.

1-3.45 Liquid Splash-Protective Glove. An element of the liquid splash-protective ensemble or an item of protective clothing designed to provide protection to the hands and wrists.

1-3.46* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

1-3.47 Maintenance. Procedures for inspection, repair and removal from service of liquid splash-protective ensembles or clothing.

1-3.48 Manufacturer. The entity that assumes the liability and provides the warranty for the compliant product.

1-3.49 Model. The collective term used to identify a group of individual liquid splash-protective ensembles or protective clothing of the same basic design and components from a single manufacturer produced by the same manufacturing and quality assurance procedures that are covered by the same certification.

1-3.50 Nonencapsulating. A type of liquid splash-protective ensemble that does not provide liquidtight, vaportight, or gastight protection. *(See also definitions 1-3.42, Liquid Splash-Protective Ensemble; 1-3.24, Encapsulating Ensemble; and 1-3.50, Nonencapsulating Ensemble.)*

1-3.51 Nonencapsulating Ensemble. The elements of the nonencapsulating liquid splash-protective ensemble are garments, gloves, and footwear that provide protection to the upper and lower torso, head, hands, and feet but do not cover the wearer's respiratory protection. The nonencapsulating liquid splash-protective ensemble does not provide liquidtight protection. *(See also definitions 1-3.23, Encapsulating and 1-3.50, Nonencapsulating.)*

1-3.52 Outer Boot. A secondary boot worn over footwear item or a bootie that provides physical protection for the chemical-protective material in order for liquid splash-protective footwear to meet certain requirements of this standard.

1-3.53 Outer Garment. A secondary garment worn over another garment that provides physical protection for the chemical-protective material in order for liquid splash-protective garment to meet certain requirements of this standard.

1-3.54 Outer Glove. A secondary glove worn over another glove that provides physical protection for the chemical-protective material in order for the liquid splash-protective glove to meet certain requirements of this standard.

1-3.55 Particulates. Solid matter that is dispersed in air as a mixture. For the purpose of this standard, particulates do not include aerosols or suspended liquid droplets in air. Aerosols are considered liquids.

1-3.56 Primary Suit Materials. Liquid splash-protective ensemble and clothing materials limited to the garment material, hood material, visor material, glove material, and footwear material that provide protection from chemical and physical hazards. This includes, in addition to the above materials, the wearer's respiratory protective equipment when designed to be worn outside the liquid splash-protective ensemble, the umbilical air hose, and all other exposed respiratory protective equipment materials designed to protect the wearer's breathing air and air path. Primary materials can be either single layers or composites.

1-3.57 Product Label. A label or marking affixed to each element or the element package by the manufacturer. Such labels contain compliance statements, certification statements, general information, care, maintenance, or similar data. The product label is not the certification organization's label, symbol, or identifying mark; however, the certification organization's label, symbol, or identifying mark is a part of the product label. *(See also definition 1-3.38, Labeled.)*

1-3.58 Protective Clothing. See definition 1-3.41, Liquid Splash-Protective Clothing.

1-3.59 Protective Clothing Items. Those individual items of liquid splash-protective clothing that are not ensemble elements or otherwise part of an ensemble. Protective clothing items are garments, gloves, and footwear.

1-3.60 Protective Ensemble. See definition 1-3.42, Liquid Splash-Protective Ensemble.

1-3.61 Protective Garment. See definition 1-3.44, Liquid Splash-Protective Garment.

1-3.62 Protective Gloves. See definition 1-3.45, Liquid Splash-Protective Glove.

1-3.63 Protective Footwear. See definition 1-3.43, Liquid Splash-Protective Footwear.

1-3.64 Radiological Agents. Radiation associated with X-rays, alpha, beta, and gamma emissions from radioactive isotopes, or other materials in excess of normal background radiation levels.

1-3.65 Recall System The action taken by which a manufacturer identifies an element, provides notice to the users, withdraws an element from the marketplace and distribution sites, and the element is returned to the manufacturer or other acceptable location for corrective action.

1-3.66 Seam. Any permanent attachment of two or more chemical-protective clothing materials, excluding external fittings, gaskets, and suit closure assemblies, in a line formed by joining the separate material pieces.

1-3.67 Shall. Indicates a mandatory requirement.

1-3.68 Should. Indicates a recommendation or that which is advised but not required.

1-3.69 Storage Life. The date to remove from services a vapor-protective ensemble, or separable elements of the ensemble, that has undergone proper care and maintenance in accordance with the manufacturer's instructions but has not been used either in training or for actual use.

1-3.70 Vapor-Protective Ensemble. A protective ensemble that protects against chemical vapors, gases, liquids, and particulates and that is certified as compliant at least to all base requirements of NFPA 1991, *Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies*.

1-3.71 Visor Material. The transparent chemical-protective material that allows the wearer to see outside the liquid splash-protective ensemble hood.

1-4* Units.

1-4.1 In this standard, values for measurement are followed by an equivalent in parentheses, but only the first stated value shall be regarded as the requirement.

1-4.2 Equivalent values in parentheses shall not be considered as the requirement, as these values might be approximate.

Chapter 2 Certification

2-1 General.

2-1.1* All individual liquid splash-protective clothing items and liquid splash-protective ensembles that are labeled as being compliant with this standard shall meet or exceed all applicable requirements specified in this standard and shall be certified. Manufacturers shall not claim compliance with a portion(s) or segment(s) of the requirements of this standard and shall not use the name or identification of this standard, NFPA 1992, in any statements about their respective products unless the product is certified to this standard.

2-1.2 Liquid splash-protective ensembles, or individual liquid splash-protective clothing items, shall not be certified for chemicals or specific chemical mixtures with known or suspected carcinogenicity as indicated by any one of the following documents:

(1) *Dangerous Properties of Industrial Chemicals*
(2) *NIOSH Pocket Guide to Chemical Hazards*

2-1.3 Liquid splash-protective ensembles, or individual liquid splash-protective clothing items, shall not be certified for chemicals or specific chemical mixtures with skin notations as indicated by the American Conference of Governmental Industrial Hygienists, *Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices*.

2-1.4 All certification shall be performed by a certification organization that meets at least the requirements specified in Section 2-2 and that is accredited for personal protective equipment in accordance with ANSI Z34.1, *Standard for Third-Party Certification Programs for Products, Processes, and Services*.

2-1.5 Compliant liquid splash-protective clothing items and liquid splash-protective elements shall be labeled and listed. All individual protective clothing items and elements of liquid splash-protective ensembles shall also have a product label. The product label shall meet the applicable requirements specified in Section 3-1.

2-1.5.1 Glove ensemble elements and footwear ensemble elements that are provided, sold, or distributed as part of a specific ensemble shall not be required to be separately labeled and listed but shall be included as a part of the ensemble product label and listing. The designation of which elements are certified as compliant with a specific ensemble(s) shall be clearly indicated on the product labels of both the element and the ensemble.

2-1.5.2 Glove and footwear protective clothing items that are manufactured as separate items and are not intended to be provided, sold, or distributed as part of a complete ensemble shall be certified as a protective clothing item.

2-1.6 Where liquid splash-protective clothing items and ensembles are certified for additional chemicals and chemical mixtures as provided for in 5-1.3, they shall also meet or exceed all applicable requirements specified in this standard.

2-1.7 The certification organization shall not certify any liquid splash-protective clothing or ensembles to the 1994 edition of this standard on or after 1 September 2000.

2-1.8* The certification organization shall not permit any manufacturer to label any liquid splash-protective clothing or ensembles to the 1994 edition of this standard on or after 1 September 2000.

2-1.9 The certification organization shall require manufacturers to remove all certification labels and product labels indicating compliance with the 1994 edition of this standard from all liquid splash-protective clothing and ensembles that are under the control of the manufacturer on 1 September 2000. The certification organization shall verify this action is taken.

2-1.10 The certification organization's label, symbol, or identifying mark shall be part of the product label.

2-2 Certification Program.

2-2.1* The certification organization shall not be owned or controlled by manufacturers or vendors of the product being certified. The certification organization shall be primarily engaged in certification work and shall not have a monetary interest in the product's ultimate profitability.

2-2.2 The certification organization shall refuse to certify products to this standard that do not comply with all requirements of this standard.

2-2.3* The contractual provisions between the certification organization and the manufacturer shall specify that certification is contingent on compliance with all applicable requirements of this standard. There shall be no conditional, temporary, or partial certifications. Manufacturers shall not be authorized to use any label or reference to the certification organization on products that are not manufactured in compliance with all applicable requirements of this standard.

2-2.4* The certification organization shall have laboratory facilities and equipment for conducting proper tests, a program for calibration of all instruments shall be in place and operating, and procedures shall be in use to ensure proper control of all testing. Good practice shall be followed regarding the use of laboratory manuals, form data sheets, documented calibration and calibration routines, performance verification, proficiency testing, and staff qualification and training programs.

2-2.5 The certification organization shall require the manufacturer to establish and maintain a program of production inspection and testing that at least meets the requirements of Section 2-4. The certification organization shall ensure that the audit assurance program provides continued product compliance with this standard.

2-2.6 The certification organization and the manufacturer shall evaluate any changes affecting the form, fit, or function of the certified product to determine its continual certification of this standard.

2-2.7* The certification organization shall have a follow-up inspection program of the manufacturing facilities of the certified product, with at least two random and unannounced visits per 12-month period. As part of the follow-up inspection program, the certification organization shall select sample product at random from the manufacturer's production line, from the manufacturer's in-house stock, or from the open market. The certification organization shall have a statistically validated process for determining the critical inspections and tests to be conducted through this follow-up program to verify the continued compliance of the product or component.

2-2.8 The certification organization shall have a program for investigating field reports alleging malperformance or failure of listed products.

2-2.9* The certification organization shall require the manufacturer to have a product recall system as part of the manufacturer's quality assurance program.

2-2.10 The operating procedures of the certification organization shall provide a mechanism for the manufacturer to appeal decisions. The procedures shall include the presentation of information from both sides of a controversy to a designated appeals panel.

2-2.11 The certification organization shall be in a position to use legal means to protect the integrity of its name and label. The name and label shall be registered and legally defended.

2-3 Inspection and Testing.

2-3.1 For both certification and recertification of ensembles, ensemble elements, and components, the certification organization shall conduct both inspection and testing as specified in this section.

2-3.2 All inspections, evaluations, conditioning, and testing for certification or for recertification shall be conducted by the certification organization or a facility accredited by the certification organization for inspections, evaluations, conditioning, and testing in accordance with all requirements pertaining to testing laboratories in ISO Guide 25, *General Requirements for the Competence of Calibration and Testing Laboratories*.

2-3.3 All inspections, evaluations, conditioning, or testing conducted by a product manufacturer shall not be used in the certification or recertification process unless the facility for inspections, evaluations, conditioning, or testing has been accredited by the certification organization in accordance with all requirements pertaining to testing laboratories in ISO Guide 25, *General Requirements for the Competence of Calibration and Testing Laboratories*.

2-3.4 The certification organization shall test individual elements with the specific ensemble(s) they are to be certified with in accordance with the requirements of 2-1.5.

2-3.5 Sampling levels for testing and inspection shall be established by the certification organization and the manufacturer to assure a reasonable and acceptable reliability at a reasonable and acceptable confidence level that products certified to this standard are compliant unless such samples levels are specified herein. This information shall be included in the manufacturer's technical data package.

2-3.6 Inspection by the certification organization shall include a review of all product labels to ensure that all required label attachment, compliance statements, certification statements, and other product information are at least as specified for the specific item in Section 3-1.

2-3.7 Inspection by the certification organization shall include a review of any graphic representations used on product labels, as permitted by 3-1.1.7, to ensure that the systems are consistent with the worded statements, readily understood, and clearly communicate the intended message.

2-3.8 Inspection by the certification organization shall include a review of the user information required by 3-1.5 to ensure that the information has been developed and is available.

2-3.9 Inspection by the certification organization for determining compliance with the design requirements specified in Chapter 4 shall be performed on whole or complete products. The certification organization shall report on the compliance of each element to each design requirement specified in Chapter 4 for that element.

2-3.10 Testing conducted by the certification organization, in accordance with the testing requirements of Chapter 6, for determining product compliance with the applicable requirements specified in Chapter 5 shall be performed on samples representative of materials and components used in the actual construction of the liquid splash-protective clothing items and ensembles. The certification organization shall also be permitted to use sample materials cut from a representative product.

2-3.11 The certifying organization shall review the technical data package to determine compliance with the requirements of Section 3-3.

2-3.12 Any change in the design, construction, or material of a compliant product shall necessitate new inspection and testing to verify compliance to all applicable requirements of this standard that the certification organization determines can be affected by such change. This recertification shall be conducted before labeling the modified products as being compliant with this standard.

2-3.13 The certification organization shall not allow any modifications, pretreatment, conditioning, or other such special processes of the product or any product component prior to the product's submission for evaluation and testing by the certification organization. The certification organization shall accept, from the manufacturer for evaluation and testing for certification, only product or product components that are the same in every respect to the actual final product or product component. The certification organization shall not allow the substitution, repair, or modification, other than as specifically permitted herein, of any product or any product component during testing.

2-3.14 Unless otherwise specified, a new set of specimens shall be used for all tests, including testing where multiple sample conditioning is used.

2-3.15* Other than where noted, any combination of materials or multipiece element that is needed to meet any of the performance requirements specified in Chapter 5 of this standard shall also be required to meet all the requirements for that particular item of the liquid splash-protective clothing or ensemble.

2-3.16 The manufacturer shall maintain all design and performance inspection and test data from the certification organization used in the certification of the manufacturer's compliant product. The manufacturer shall provide such data, upon request, to the purchaser or authority having jurisdiction.

2-4 Recertification.

2-4.1 All individual elements of the protective ensemble that are labeled as being compliant with this standard shall undergo recertification on an annual basis. This recertification shall include inspection and evaluation to all design requirements and testing to all performance requirements as required by this standard on all manufacturer models and components as specified in 2-4.3.

2-4.1.1 Any change that affects the element's performance under design or performance requirements of this standard shall constitute a different model.

2-4.1.2 For the purpose of this standard, models shall include each unique pattern, style, or design of the individual element.

2-4.2 Samples of manufacturer's models and components for recertification shall be acquired from the manufacturer or component supplier during random and unannounced visits as part of the follow-up inspection program. For recertification, the certification organization shall acquire at least one liquid splash-protective garment, one pair of liquid splash-protective gloves, one pair of liquid splash-protective footwear, and one complete liquid splash-protective nonencapsulating or encapsulating ensemble outfitted with all manufacturer-provided external fittings. The certification organization shall also acquire a sufficient quantity of component samples to be tested for recertification as required by 2-4.3.

2-4.3 Sample liquid splash-protective garments, gloves, footwear, ensembles, and components shall be inspected, evaluated, and tested for annual recertification.

2-4.3.1 Each liquid splash-protective garment, glove, footwear, and ensemble shall be inspected and evaluated to each of the design requirements specified in Chapter 4.

2-4.3.2 Each liquid splash-protective ensemble specimen shall be tested for overall performance as specified in Section 5-1 using the following sequence of tests:

(1) The liquid splash-protective ensemble specimen shall then be tested for liquidtight integrity as specified in Section 6-2, Liquidtight Integrity Test One.
(2) The liquid splash-protective ensemble specimen shall then be tested for overall function and integrity as specified in Section 6-3, Overall Garment Function and Integrity Test.
(3) If certified for optional chemical flash fire protection, the liquid splash-protective ensemble shall then be tested for overall ensemble flash protection as specified in Section 6-19, Overall Ensemble Flash Test.

2-4.3.3 All garment material, visor, glove, footwear, and optional chemical flash fire protection performance requirements shall be evaluated as specified in Chapter 5 with the following modifications:

(1) Penetration resistance testing specified in 5-1.3, 5-1.7.1, 5-1.8.1, 5-2.2, and 5-3.2 shall be performed against the following chemicals:
    a. Acetone
    b. 93.1 percent w/w sulfuric acid
    c. Hexane
    d. Tetrahydrofuran
(2) A total of two specimens shall be permitted for testing requirements. If the testing is specified for both directions of a material, a total of two specimens per material direction shall be permitted for testing requirements.

2-4.4 The manufacturer shall maintain all design and performance inspection and test data from the certification organization used in the recertification of manufacturer's models and components. The manufacturer shall provide such data, upon request, to the purchaser or the authority having jurisdiction.

2-5 Manufacturer's Quality Assurance Program.

2-5.1 The manufacturer shall provide and maintain a quality assurance program that includes a documented inspection and product recall system. The manufacturer shall have an inspection system to substantiate conformance to this standard.

2-5.2 The manufacturer shall maintain written inspection and testing instructions. The instructions shall prescribe inspection and testing of materials, work in process, and completed articles. Criteria for acceptance and rejection of materials, processes, and final product shall be part of the instructions.

2-5.3 The manufacturer shall maintain records of all pass/fail tests. Pass/fail records shall indicate the disposition of the failed material or product.

2-5.4 The manufacturer's inspection system shall provide for procedures that ensure the latest applicable drawings, specifications, and instructions are used for fabrication, inspection, and testing.

2-5.5 The manufacturer shall, as part of the quality assurance program, maintain a calibration program of all instruments used to ensure proper control of testing. The calibration program shall be documented as to the date of calibration and performance verification.

2-5.6 The manufacturer shall maintain a system for identifying the appropriate inspection status of component materials, work in process, and finished goods.

2-5.7 The manufacturer shall establish and maintain a system for controlling nonconforming material, including procedures for the identification, segregation, and disposition of rejected material. All nonconforming materials or products shall be identified to prevent use, shipment, and intermingling with conforming materials or products.

2-5.8 The manufacturer's quality assurance program shall be audited by the third-party certification organization to determine that the program is sufficient to ensure continued product compliance with this standard.

2-6 ISO Registration for Manufacturers.

2-6.1 The manufacturer shall provide and operate a quality assurance program that meets the requirements of this section and that includes a product recall system as specified in 2-2.9.

2-6.2 The manufacturer shall be registered to ISO 9001, *Quality Systems — Model for Quality Assurance in Design, Development, Production, Installation, and Servicing.*

2-6.3 The ISO registration requirements shall have an effective date of 1 March 2002.

2-6.4 Until 1 March 2002, or until the date the manufacturer becomes ISO registered, whichever date occurs first, the manufacturer shall comply with Section 2-5.

Chapter 3 Labeling and Information

3-1 Product Label Requirements.

3-1.1 General.

3-1.1.1* Each liquid splash-protective garment shall have a product label permanently and conspicuously attached to or printed on each garment when the garment is properly assembled with all layers, components, and component parts in place.

3-1.1.2 Each liquid splash-protective glove shall have a product label permanently and conspicuously attached to or printed on the top outside of the gauntlet of each glove piece when the glove is properly assembled with all layers, components, and component parts in place. In addition, each package containing one or more pairs of liquid splash-protective gloves shall have a product label attached to, printed on, or inserted in the glove package.

3-1.1.3 All liquid splash-protective footwear shall have a product label permanently and conspicuously attached to or printed on the inside of each footwear piece when the footwear is properly assembled with all layers, components, and component parts in place. In addition, each package containing one or more pairs of liquid splash-protective footwear shall have a product label attached to, printed on, or inserted in the footwear package.

3-1.1.4 Each liquid splash-protective ensemble and each individual element shall have a product label permanently and conspicuously attached to or printed on the inside of each ensemble or individual element when the ensemble or element is properly assembled with all layers, components, and component parts in place.

3-1.1.5* Multiple label pieces shall be permitted in order to carry all statements and information required to be on the product label; however, all label pieces comprising the entire product label shall be located adjacent to each other.

3-1.1.6 All worded portions of the required product label shall at least be in English.

3-1.1.7 Symbols and other pictorial graphic representations shall be permitted to be used to supplement worded statements on the product label(s).

3-1.1.8* The certification organization's label, symbol, or identifying mark shall be legibly printed on the product label. All letters shall be at least 2.5 mm ($^3/_{32}$ in.) high.

3-1.1.9 The compliance statements and information specified in 3-1.2 through 3-1.6, as applicable for the specific protective clothing item or ensemble, shall be legibly printed on the product label. All letters shall be at least 3 mm ($^1/_8$ in.) high.

3-1.1.10 In addition to the compliance statements specified in 3-1.1.9, at least the following information shall also be printed legibly on the product label(s). All letters shall be at least 2 mm ($^1/_{16}$ in.) high.

(1) Manufacturer's name, identification, or designation
(2) Manufacturer's address
(3) Country of manufacture
(4) Model, style, or serial number
(5) Size
(6) Garment, glove, footwear, ensemble material(s), as applicable
(7) Visor material(s) if provided
(8) Glove component for ensemble
(9) Footwear component for ensemble

3-1.1.11 Where detachable components, including, but not limited to, outer garments, outer gloves, or outer boots, must be worn with a liquid splash-protective clothing item or ensemble in order for the protective clothing item or ensemble to be compliant with this standard, at least the following statement and information shall also be printed legibly on the product label. All letters shall be at least 2.5 mm ($^3/_{32}$ in.) high. The appropriate term of "garment," "glove," "footwear," or "ensemble" shall be inserted where indicated in the label text. The detachable component(s) shall be listed following this statement by type, identification, and how properly worn.

"FOR COMPLIANCE WITH NFPA 1992, THE FOLLOWING ADDITIONAL COMPONENTS MUST BE WORN IN CONJUNCTION WITH THIS VAPOR-PROTECTIVE (insert the term 'GARMENT,' 'GLOVE,' 'FOOTWEAR,' or 'ENSEMBLE' here)":

(List detachable components here.)

3-1.1.12 Detachable components specified in 3-1.1.11 shall meet the label requirements specified in ASTM F 1301, *Standard Practice for Labeling Chemical Protective Clothing.* The label shall also meet the requirements of 3-1.1.1 through 3-1.1.8.

3-1.2 Garment Compliance Statements.

3-1.2.1 Each liquid splash-protective garment shall have at least the following compliance statements and information on the product label.

"THIS LIQUID SPLASH-PROTECTIVE GARMENT MEETS THE BASIC REQUIREMENTS OF NFPA 1992, STANDARD ON LIQUID SPLASH-PROTECTIVE ENSEMBLES AND CLOTHING FOR HAZARDOUS MATERIALS EMERGENCIES, 2000 EDITION, AND FOR THE ADDITIONAL REQUIREMENT IF INDICATED BELOW.

ADDITIONAL REQUIREMENT	YES	NO
***LIMITED* CHEMICAL FLASH FIRE PROTECTION FOR *ESCAPE ONLY* IN THE EVENT OF A CHEMICAL FLASH FIRE**		

THE TECHNICAL DATA PACKAGE CONTAINS INFORMATION ON CHEMICALS AND SPECIFIC CHEMICAL MIXTURES FOR WHICH THIS GARMENT IS CERTIFIED. CONSULT THE TECHNICAL DATA PACKAGE AND MANUFACTURER'S INSTRUCTIONS BEFORE USE.

DO NOT REMOVE THIS LABEL."

3-1.2.2 Where the garment does provide the optional limited chemical flash fire protection above the basic requirements of this standard, the YES box shall be marked. Where the garment does not provide the optional limited chemical flash fire protection above the basic requirements of this standard, the NO box shall be marked.

3-1.3 Glove Compliance Statements.

3-1.3.1 Each liquid splash-protective glove shall have at least the following compliance statements and information on the product label.

"THIS LIQUID SPLASH-PROTECTIVE GLOVE MEETS THE BASIC REQUIREMENTS OF NFPA 1992, STANDARD ON LIQUID SPLASH-PROTECTIVE ENSEMBLES AND CLOTHING FOR HAZARDOUS MATERIALS EMERGENCIES, 2000 EDITION, AND FOR THE ADDITIONAL REQUIREMENT IF INDICATED BELOW.

ADDITIONAL REQUIREMENT	YES	NO
***LIMITED* CHEMICAL FLASH FIRE PROTECTION FOR *ESCAPE ONLY* IN THE EVENT OF A CHEMICAL FLASH FIRE**		

THE TECHNICAL DATA PACKAGE CONTAINS INFORMATION ON CHEMICALS AND SPECIFIC CHEMICAL MIXTURES FOR WHICH THIS GLOVE IS CERTIFIED. CONSULT THE TECHNICAL DATA PACKAGE AND MANUFACTURER'S INSTRUCTIONS BEFORE USE.

DO NOT REMOVE THIS LABEL."

3-1.3.2 Where the glove does provide the optional limited chemical flash fire protection above the basic requirements of this standard, the YES box shall be marked. Where the glove does not provide the optional limited chemical flash fire protection above the basic requirements of this standard, the NO box shall be marked.

3-1.4 Footwear Compliance Statements.

3-1.4.1 Each liquid splash-protective footwear piece shall have at least the following compliance statements and information on the product label.

"THIS LIQUID SPLASH-PROTECTIVE FOOTWEAR MEETS THE BASIC REQUIREMENTS OF NFPA 1992, STANDARD ON LIQUID SPLASH-PROTECTIVE ENSEMBLES AND CLOTHING FOR HAZARDOUS MATERIALS EMERGENCIES, 2000 EDITION, AND FOR THE ADDITIONAL REQUIREMENT IF INDICATED BELOW.

ADDITIONAL REQUIREMENT	YES	NO
***LIMITED* CHEMICAL FLASH FIRE PROTECTION FOR *ESCAPE ONLY* IN THE EVENT OF A CHEMICAL FLASH FIRE**		

THE TECHNICAL DATA PACKAGE CONTAINS INFORMATION ON CHEMICALS AND SPECIFIC CHEMICAL MIXTURES FOR WHICH THIS FOOTWEAR IS CERTIFIED. CONSULT TECHNICAL DATA PACKAGE AND MANUFACTURER'S INSTRUCTIONS BEFORE USE.

DO NOT REMOVE THIS LABEL."

3-1.4.2 Where the footwear does provide the optional limited chemical flash fire protection above the basic requirements of this standard, the YES box shall be marked. Where the footwear does not provide the optional limited chemical flash fire protection above the basic requirements of this standard, the NO box shall be marked.

3-1.5 Nonencapsulating Ensemble Compliance Statements.

3-1.5.1 Each nonencapsulating liquid splash-protective ensemble shall have at least the following compliance statements and information on the product label.

"THIS NONENCAPSULATING LIQUID SPLASH-PROTECTIVE ENSEMBLE MEETS THE BASIC REQUIREMENTS OF NFPA 1992, STANDARD ON LIQUID SPLASH-PROTECTIVE ENSEMBLES AND CLOTHING FOR HAZARDOUS MATERIALS EMERGENCIES, 2000 EDITION, AND FOR THE ADDITIONAL REQUIREMENT IF INDICATED BELOW.

ADDITIONAL REQUIREMENT	YES	NO
***LIMITED* CHEMICAL FLASH FIRE PROTECTION FOR *ESCAPE ONLY* IN THE EVENT OF A CHEMICAL FLASH FIRE**		

THE TECHNICAL DATA PACKAGE CONTAINS INFORMATION ON CHEMICALS AND SPECIFIC CHEMICAL MIXTURES FOR WHICH THIS NONENCAPSULATING ENSEMBLE IS CERTIFIED. CONSULT THE TECHNICAL DATA PACKAGE AND MANUFACTURER'S INSTRUCTIONS BEFORE USE.

DO NOT REMOVE THIS LABEL."

3-1.5.2 Where the nonencapsulating ensemble does provide the optional limited chemical flash fire protection above the

basic requirements of this standard, the YES box shall be marked. Where the nonencapsulating ensemble does not provide the optional limited chemical flash fire protection above the basic requirements of this standard, the NO box shall be marked.

3-1.6 Encapsulating Ensemble Compliance Statements.

3-1.6.1 Each encapsulating liquid splash-protective ensemble shall have at least the following compliance statements and information on the product label.

"THIS ENCAPSULATING LIQUID SPLASH-PROTECTIVE ENSEMBLE MEETS THE BASIC REQUIREMENTS OF NFPA 1992, STANDARD ON LIQUID SPLASH-PROTECTIVE ENSEMBLES AND CLOTHING FOR HAZARDOUS MATERIALS EMERGENCIES, 2000 EDITION, AND FOR THE ADDITIONAL REQUIREMENT IF INDICATED BELOW.

ADDITIONAL REQUIREMENT	YES	NO
***LIMITED* CHEMICAL FLASH FIRE PROTECTION FOR *ESCAPE ONLY* IN THE EVENT OF A CHEMICAL FLASH FIRE**		

THE TECHNICAL DATA PACKAGE CONTAINS INFORMATION ON CHEMICALS AND SPECIFIC CHEMICAL MIXTURES FOR WHICH THIS ENCAPSULATING ENSEMBLE IS CERTIFIED. CONSULT THE TECHNICAL DATA PACKAGE AND MANUFACTURER'S INSTRUCTIONS BEFORE USE.

DO NOT REMOVE THIS LABEL."

3-1.6.2 Where the encapsulating ensemble does provide the optional limited chemical flash fire protection above the basic requirements of this standard, the YES box shall be marked. Where the encapsulating ensemble does not provide the optional limited chemical flash fire protection above the basic requirements of this standard, the NO box shall be marked.

3-2* User Information.

3-2.1 The manufacturer shall provide user information including, but not limited to, warnings, information, and instructions with each individual protective clothing item or each ensemble.

3-2.2 The manufacturer shall attach the required user information, or packaging containing the user information, to the protective clothing item or element in such a manner that it is not possible to use the clothing item or element without being aware of the availability of the information.

3-2.3 The manufacturer shall provide at least the following instructions and information with each liquid splash-protective clothing item or ensemble:

(1) Pre-use information:
   a. Safety considerations
   b. Limitations of use
   c. Clothing or element marking recommendations and restrictions
   d. A statement that most performance properties of the liquid splash-protective clothing item or ensemble cannot be tested by the user in the field
   e. Closure lubricants, if applicable
   f. Visor antifog agents or procedures
   g. Recommended undergarments
   h. Shelf life
   i. Warranty information
(2) Preparation for use:
   a. Sizing/adjustment
   b. Recommended storage practices
(3) Inspection frequency and details
(4) Don/doff:
   a. Donning and doffing procedures
   b. Sizing and adjustment procedures
   c. Interface issues
(5) Proper use consistent with NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, and 29 *CFR* 1910.132
(6) Maintenance and cleaning:
   a. Cleaning instructions and precautions with a statement advising users not to use clothing or ensembles that are not thoroughly cleaned and dried
   b. Inspection details
   c. Maintenance criteria and methods of repair where applicable
   d. Decontamination procedures for both chemical and biological contamination
(7) Retirement and disposal criteria and consideration

3-2.4 The manufacturer shall state the storage life for each liquid splash-protective clothing item or ensemble.

3-3 Technical Data Package.

3-3.1* The manufacturer shall furnish a technical data package for the clothing item or ensemble upon the request of the purchaser.

3-3.2* The technical data package shall contain all documentation required by this standard and the data showing compliance with this standard.

3-3.3 In the technical data package, the manufacturer shall describe the clothing item or ensemble in terms of manufacturer trade name and model number, manufacturer replaceable components and available options, and accessories such as testing devices, and sizes.

3-3.4* Descriptions of sizes shall include the range in height and weight for persons fitting each particular size, for garments, or sizes specific in Chapter 4 for gloves and footwear, and shall provide information to the wearer as to whether these sizes apply to persons wearing SCBA, hardhats, communications devices, turnout clothing, and other similar gear.

3-3.5 Garment Material and Component Descriptions.

3-3.5.1 When specific clothing items and equipment are required for certifying the ensemble or clothing item to this standard, the manufacturer shall list these clothing items and equipment in the technical data package.

3-3.5.2 The manufacturer shall provide, in the technical data package, the list and descriptions of the following ensemble materials and components, if applicable:

(1) Garment material
(2) Visor material
(3) Glove material and type of attachment
(4) Footwear material and type of attachment
(5) Zipper/closure type and materials
(6) Material seam types and composition
(7) Exhaust valve types and material(s)
(8) External fitting types and material(s)
(9) External gasket types and material(s)
(10) Outer garment, glove, or boot material(s)
(11) Type or style of head protection accommodated within the suit

3-3.5.3 All descriptions of material composition shall specify either the generic material names or trade names if the composition of the material is proprietary.

3-3.5.4 Descriptions of respective suit materials and components shall include the following information, if applicable:

(1) Visor material:
   a. The availability of any permanent detachable covers and films
(2) Gloves:
   a. Type of linings or surface treatments
   b. Available glove sizes
(3) Footwear:
   a. Type of linings or surface treatments
   b. Type of soles or special toe reinforcements
   c. Available footwear sizes
(4) Garment zipper or closure:
   a. The material(s) of construction for the closure (including chain, slide, pull, and tape for zippers)
   b. The location and the length of the completed closure assembly
   c. A description of any protective covers for flaps
(5) Other clothing items (for example, outer garments):
   a. Type and how used with protective suit

3-3.5.5 The manufacturer shall describe, in the technical data package, the type of seams or methods of attachment for the following garment material and component combinations:

(1) Garment material–garment material
(2) Garment material–visor
(3) Garment material–glove
(4) Garment material–footwear
(5) Garment material–garment closure
(6) Outer cover–outer cover

Chapter 4 Design Requirements

4-1 Protective Garment Requirements.

4-1.1 Liquid splash-protective garments shall be designed and configured to protect the wearer's torso, arms, and legs.

4-1.2 Where used, booties shall be designed as an extension of the garment leg and shall cover the entire foot and ankle.

4-1.3 Liquid splash-protective garments shall be offered in at least four unique and different sizes.

4-1.4 All external fittings shall be free of rough spots, burrs, or sharp edges that could tear primary materials.

4-2 Protective Glove Requirements.

4-2.1 Gloves shall provide protection from the finger tips to at least 25 mm (1 in.) beyond the wrist crease.

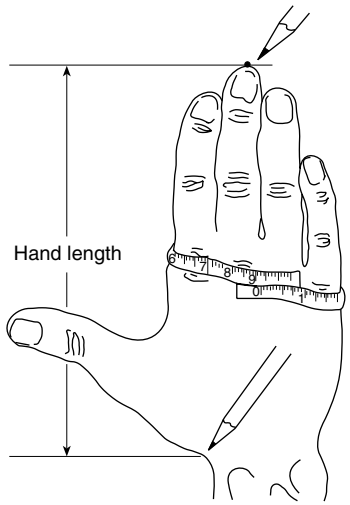
4-2.2 In order to label or otherwise represent a glove that meets the requirements of this standard, the manufacturer shall provide gloves in not less than five separate and distinct sizes. The glove size on the product label shall be determined as specified in Table 4-2.2.

Table 4-2.2 Glove Sizing

Labeled Size to Fit	Hand Circumference
XS	175 mm to 200 mm (7 in. to 8 in.)
S	200 mm to 230 mm (8 in. to 9 in.)
M	230 mm to 255 mm (9 in. to 10 in.)
L	255 mm to 280 mm (10 in. to 11 in.)
XL	280 mm to 305 mm (11 in. to 12 in.)

4-2.2.1 Hand dimensions for selection of proper glove size shall consist of taking two dimensions as shown in Figure 4-2.2.1 — the hand circumference and the length of the right hand.

FIGURE 4-2.2.1 Method of measuring hand dimensions for selection of proper glove sizes.



4-2.2.2 Hand circumference shall be measured by placing the measuring tape on a table or other flat surface with the numerals facing downward. The subject shall place the right hand, palm down and fingers together, in the middle of the tape so that the tape can pass straight across the hand just beneath the knuckles (metacarpal). The circumference shall be measured to the nearest eighth of an inch, as shown in Figure 4-2.2.1.

4-2.3 The glove to liquid splash-protective garment sleeve interface shall be designed to permit removal and replacement of the gloves attached to each garment sleeve within 30 minutes.

4-3 Protective Footwear Requirements.

4-3.1 Footwear shall provide protection not less than 200 mm (8 in.) in height when measured from the plane of the sole bottom.

4-3.2 Heel breast shall not be less than 13 mm ($^1/_2$ in.) nor more than 25 mm (1 in.) Heel breasting angle shall not be less than 90 degrees nor more than 135 degrees. Sides and rear of heel shall not be flared or tapered, and edges shall not be less than, or extend more than, 13 mm ($^1/_2$ in.) laterally from the upper at any point.

4-3.3 Footwear shall be available in all of men's sizes 6 through 15 and all of women's sizes 5 through 10 when measured in accordance with Footwear Industries of America, *Shoe Size Conversion, Research Results and Recommendations.*

4-3.4 Metal parts shall not penetrate from the outside into the lining or insole at any point.

4-3.5 No metal parts, including but not limited to nails or screws, shall be present or utilized in the construction or attachment of the sole (with heel) to the puncture-resistant device, insole, or upper.

4-4 Nonencapsulating Ensemble Requirements.

4-4.1 Nonencapsulating protective ensembles shall be designed and configured to protect the wearer's torso, head, arms, legs, hands, and feet and shall completely enclose the wearer but shall not completely enclose the wearer's respiratory protective equipment.

4-4.2 Garment elements of nonencapsulating ensembles shall meet the design requirements in Section 4-1, Protective Garment Requirements.

4-4.3 Glove elements of nonencapsulating ensembles shall meet the design requirements in Section 4-2, Protective Glove Requirements.

4-4.4 Footwear elements of nonencapsulating ensembles shall meet the design requirements in Section 4-3, Protective Footwear Requirements.

4-4.5 Where booties are used as part of a nonencapsulating protective ensemble, the manufacturer shall specify types of compliant outer footwear that provide the performance requirements for footwear as specified in 5-3.2 through 5-3.9.

4-5 Encapsulating Ensembles Requirements.

4-5.1 Encapsulating protective ensembles shall be designed and configured to protect the wearer's torso, head, arms, legs, hands, feet, and respiratory equipment and shall completely enclose the wearer and the wearer's respiratory equipment.

4-5.2 Garment elements of encapsulating ensembles shall meet the design requirements in Section 4-1, Protective Garment Requirements.

4-5.3 Glove elements of encapsulating ensembles shall meet the design requirements in Section 4-2, Protective Glove Requirements.

4-5.4 Footwear elements of encapsulating ensembles shall meet the design requirements in Section 4-3, Protective Footwear Requirements.

4-5.5 Encapsulating ensembles shall include an integral hood with visor and shall include attached gloves and attached footwear.

4-5.5.1 Attached footwear shall be permitted to be booties.

4-5.5.2 Where booties are provided in the construction of the encapsulating ensemble, the manufacturer shall specify types of compliant outer footwear that provide the performance requirements for footwear as specified in 5-3.2 through 5-3.9.

4-6 Optional Chemical Flash Fire Protection Requirements. Where liquid splash-protective garments or ensembles rely on external clothing items or multiple layers to meet the performance requirements in Section 5-4, the liquid splash-protective garment or liquid splash-protective ensemble shall be designed so that all layers or separate parts of elements are securely attached and provided as a single and integrated unit.

4-7 Accessory Design Requirements.

4-7.1 Any accessories attached to any clothing item or element of the liquid splash-protective ensemble shall not interfere with the function of the element or with the function of any of the element's component parts.

4-7.2 Any accessories attached to any clothing item or element of the liquid splash-protective ensemble shall not degrade the designed protection or performance of the element below the requirements of this standard.

Chapter 5 Performance Requirements

5-1 Protective Garment Requirements.

5-1.1 Garments shall be tested for liquidtight integrity as specified in Section 6-2, Liquidtight Integrity Test One, and shall allow no liquid penetration.

5-1.2 Garments shall be tested for overall function and integrity as specified in Section 6-3, Overall Garment Function and Integrity Test, and shall allow the test subject to complete all tasks and shall allow no liquid penetration in subsequent liquidtight integrity testing as specified in Section 6-2, Liquidtight Integrity Test One.

5-1.2.1 Where hoods are provided, garments shall accommodate head protection devices meeting the dimensional requirements for Type I, Class G helmets of ANSI Z89.1, *Standard for Industrial Head Protection.*

5-1.2.2 Where hoods with visors are provided, garments shall permit the test subject to see through the visor with a visual acuity of 20/35 or better.

5-1.2.3 Where a protective flap is used over the closure system, it shall remain closed over the duration of the overall garment function test.

5-1.3 Garment materials shall be tested for penetration resistance after flexing and abrasion as specified in Section 6-4, Chemical Penetration Resistance Test, and shall exhibit no penetration for at least 1 hour for the following list of chemicals, and shall exhibit no penetration for at least 1 hour for each additional chemical or specific chemical mixture for which the manufacturer is certifying the garment.

(1) Acetone
(2) Acetonitrile

(3) Ethyl acetate
(4) Hexane
(5) 50 percent w/w sodium hydroxide
(6) 93.1 percent w/w sulfuric acid
(7) Tetrahydrofuran

5-1.4 Garment materials shall be tested for bursting strength as specified in Section 6-5, Burst Strength Test, and shall have a bursting strength of not less than 134 N (30 lb force).

5-1.5 Garment materials shall be tested for puncture propagation tear resistance as specified in Section 6-6, Puncture Propagation Tear Resistance Test, and shall have a puncture propagation tear resistance of not less than 25 N (5.6 lb force).

5-1.6 Garment materials shall be tested for cold weather performance as specified in Section 6-7, Cold Temperature Performance Test One, and shall have a bending moment of not greater than 0.68 N × m (0.50 lb × in.) at a angular deflection of 60 degrees and −25°C (−13°F).

5-1.7 Garment Visor Requirements.

5-1.7.1 Where provided, visor materials shall be tested for penetration resistance as specified in Section 6-4, Chemical Penetration Resistance Test, and shall exhibit no penetration for at least 1 hour for each of the NFPA battery of chemicals and for each additional chemical or specific chemical mixture for which the manufacturer is certifying the garment.

5-1.7.2 Where provided, visor materials shall be tested for bursting strength as specified in Section 6-5, Burst Strength Test, and shall have a bursting strength of not less than 134 N (30 lb force).

5-1.7.3 Where provided, visor materials shall be tested for puncture propagation tear resistance as specified in Section 6-6, Puncture Propagation Tear Resistance Test, and shall have a puncture propagation tear resistance of not less than 2.5 kg (5.5 lb).

5-1.7.4 Visor materials shall be tested for cold temperature bending at −25°C (−13°F) as specified in Section 6-7, Cold Temperature Performance Test One, and shall not crack or show evidence of visible damage.

5-1.8 Garment Seam Requirements.

5-1.8.1 Garment seams, and visor seams where visors are provided, shall be tested for penetration resistance as specified in Section 6-4, Chemical Penetration Resistance Test, and shall exhibit no penetration for at least 1 hour for 100 percent isopropanol and 93.1 percent w/w sulfuric acid.

5-1.8.2 Garment seams, and visor seams where visors are provided, shall be tested for seam strength as specified in Section 6-8, Seam/Closure Breaking Strength Test, and shall have a breaking strength of not less than 67 N/50 mm (15 lbf/2 in.).

5-1.9 Garment Closure Assembly Requirements.

5-1.9.1 Where garment closures are not fully covered by a protective flap that is constructed of the same material as the garment, garment closure assemblies shall be tested for penetration resistance as specified in Section 6-4, Chemical Penetration Resistance Test, and shall exhibit no penetration for at least 1 hour for 100 percent isopropanol and 93.1 percent w/w sulfuric acid.

5-1.9.2 Garment closure assemblies shall be tested for closure strength as specified in Section 6-8, Seam/Closure Breaking Strength Test, and shall have a breaking strength of not less than 67 N/50 mm (15 lbf/2 in.).

5-2 Protective Glove Requirements.

5-2.1 Gloves shall be tested for liquidtight integrity as specified in Section 6-10, Liquidtight Integrity Test Two, and shall show no leakage.

5-2.2 Glove materials shall be tested for penetration resistance after flexing and abrading as specified in Section 6-4, Chemical Penetration Resistance Test, and shall exhibit no penetration for at least 1 hour for the following list of chemicals, and shall exhibit no penetration for at least 1 hour for each additional chemical or specific chemical mixture for which the manufacturer is certifying the glove.

(1) Acetone
(2) Acetonitrile
(3) Ethyl acetate
(4) Hexane
(5) 50 percent w/w sodium hydroxide
(6) 93.1 percent w/w sulfuric acid
(7) Tetrahydrofuran

5-2.3 Glove materials shall be tested for cut resistance as specified in Section 6-11, Cut Resistance Test, and shall have a cut distance resistance of not more than 25 mm (1 in.).

5-2.4 Glove materials shall be tested for puncture resistance as specified in Section 6-12, Puncture Resistance Test One, and shall have a puncture resistance of not less than 2.3 kg (5 lb).

5-2.5 Glove materials shall be tested for cold weather performance as specified in Section 6-7, Cold Temperature Performance Test One, and shall have a bending moment of 0.68 N × m (0.50 lb × in.) at an angular deflection of 60 degrees and −25°C (−13°F).

5-2.6 Glove specimens shall be tested for hand function as specified in Section 6-13, Glove Hand Function Test, and shall have an average percent increase over barehanded control less than 300 percent.

5-3 Protective Footwear Requirements.

5-3.1 Footwear shall be tested for liquidtight integrity as specified in Section 6-10, Liquidtight Integrity Test Two, and shall show no leakage.

5-3.2 Footwear upper materials shall be tested for penetration resistance after flexing and abrading as specified in Section 6-4, Chemical Penetration Resistance Test, and shall exhibit no penetration for at least 1 hour for the following list of chemicals, and shall exhibit no penetration for at least 1 hour for each additional chemical or specific chemical mixture for which the manufacturer is certifying the footwear.

(1) Acetone
(2) Acetonitrile
(3) Ethyl acetate
(4) Hexane
(5) 50 percent w/w sodium hydroxide
(6) 93.1 percent w/w sulfuric acid
(7) Tetrahydrofuran

5-3.3 Footwear upper materials shall be tested for cut resistance as specified in Section 6-11, Cut Resistance Test, and have a cut distance resistance of not more than 25 mm (1 in.).

5-3.4 Footwear upper materials shall be tested for puncture resistance as specified in Section 6-12, Puncture Resistance Test One, and have a puncture resistance of not less than 3.6 kg (8 lb).

5-3.5 Sample footwear toes shall be tested for impact and compression resistance as specified in Section 6-16, Impact and Compression Test, and shall have an impact resistance of not less than 101.7 J (75 ft-lb) and a compression resistance of not less than 11,121 N (2500 lbf).

5-3.6 Footwear soles shall be tested for puncture resistance as specified in Section 6-14, Puncture Resistance Test Two, and shall have a puncture resistance of not less than 123.4 kg (272 lb).

5-3.7 Footwear sole and heels shall be tested for abrasion resistance as specified in Section 6-15, Abrasion Resistance Test, and have an abrasion-resistance rating of not less than 65.

5-3.8 Footwear ladder shanks shall be tested for bending resistance as specified in Section 6-17, Ladder Shank Bend Resistance Test, and shall not deflect more than 6 mm ($^1/_4$ in.).

5-3.9 Footwear soles shall be tested for slip resistance as specified in Section 6-18, Slip Resistance Test, and shall have a static coefficient of 0.75 or greater.

5-4 Nonencapsulating Protective Ensemble Requirements.

5-4.1 Liquid splash-protective ensembles, with visors, gloves, and footwear shall be tested for liquidtight integrity as specified by Section 6-2, Liquidtight Integrity Test One, and shall allow no liquid penetration.

5-4.2 Garment elements of nonencapsulating ensembles shall meet the performance requirements specified in Section 5-1, Protective Garment Requirements.

5-4.3 Glove elements of nonencapsulating ensembles shall meet the performance requirements specified in Section 5-2, Protective Glove Requirements.

5-4.4 Footwear elements of nonencapsulating ensembles shall meet the performance requirements specified in Section 5-3, Protective Footwear Requirements.

5-4.4.1 Where booties are used in the construction of the nonencapsulating ensemble, the bootie shall meet the requirements specified in 5-3.1.

5-4.4.2 Where booties are used in the construction of nonencapsulating ensembles, the specified outer footwear, as required by 4-4.5, shall meet the requirements specified in 5-3.2 through 5-3.9.

5-5 Encapsulating Protective Ensemble Requirements.

5-5.1 Encapsulating liquid splash-protective ensembles, hoods with visors, gloves, and footwear shall be tested for liquidtight integrity as specified by Section 6-2, Liquidtight Integrity Test One, and shall allow no liquid penetration.

5-5.2 Garment elements of encapsulating ensembles shall meet the performance requirements specified in Section 5-1, Protective Garment Requirements.

5-5.3 Glove elements of encapsulating ensembles shall meet the performance requirements specified in Section 5-2, Protective Glove Requirements.

5-5.4 Footwear elements of encapsulating ensembles shall meet the performance requirements specified in Section 5-3, Protective Footwear Requirements.

5-5.4.1 Where booties are used in the construction of encapsulating ensembles, the bootie shall meet the requirements specified in 5-3.1.

5-5.4.2 Where booties are used in the construction of encapsulating ensembles, the specified outer footwear, as required by 4-5.5.2, shall meet the requirements specified in 5-3.2 through 5-3.9.

5-6 Optional Chemical Flash Fire Protection Requirements.

5-6.1 Liquid splash-protective ensembles shall be tested for overall garment flash protection as specified by Section 6-19, Overall Ensemble Flash Test, and shall show afterflame times no longer than 2 seconds; in subsequent testing by test subjects of the ensemble shall allow no liquid penetration; and where a hood with visor is provided shall allow test subjects to have a visual acuity of 20/100.

5-6.2 Garment, glove, and footwear materials shall be tested for thermal protective performance (TPP) as specified in Section 6-20, Thermal Protective Performance Test, and shall have an average TPP rating of not less than 12.

5-6.3 Garment, visor, glove, and footwear materials shall be tested for resistance to flame impingement as specified in Section 6-21, Flammability Resistance Test, and shall not ignite during the initial 3-second exposure period, shall not burn a distance of greater than 100 mm (4 in.), shall not sustain burning for more than 2 seconds, and shall not melt as evidenced by flowing or dripping during the subsequent 12-second exposure period.

5-6.4 Garment and glove materials shall be tested for the rate of static electric discharge as specified in Section 6-22, Static Charge Accumulation Resistance Test, and shall show no voltage greater than 350 V, 5 seconds after termination of charge generation.

5-7 Optional Encapsulating and Chemical Flash Fire Escape Protection Requirements.

5-7.1 Encapsulating liquid splash-protective ensemble elements, with a visor, shall meet the requirements in Sections 5-1 through 5-5.

5-7.2 Liquid splash-protective clothing specimens of garments, gloves, and footwear shall meet the requirements in Sections 5-1 through 5-5.

Chapter 6 Test Methods

6-1 Sample Preparation Procedures.

6-1.1 Application.

6-1.1.1 The sample preparation procedures contained in this section shall apply to each test method in this chapter, as specifically referenced in the sample preparation section of each test method.

6-1.1.2 Only the specific sample preparation procedure or procedures referenced in the sample preparation section of each test method shall be applied to that test method.

6-1.2 Room Temperature Conditioning Procedure.

6-1.2.1 Specimens shall be conditioned at a temperature of 21°C, ±3°C (70°F, ±5°F) and a relative humidity of 65 percent, ±5 percent until equilibrium is reached as determined in accordance with Section 4, of Federal Test Method Standard 191A, *Textile Test Methods*, or for at least 24 hours, whichever is shortest.

6-1.2.2 Specimens shall be tested within 5 minutes after removal from conditioning.

6-1.3 Flexural Fatigue Procedure for Garment Materials.

6-1.3.1 Specimens shall be subjected to flexural fatigue in accordance with ASTM F 392, *Standard Test Method for Flex Durability of Flexible Barrier Materials*, with the following modifications:

(1) In lieu of Flexing Conditions A, B, C, D, or E, test specimens shall have a flex period of 100 cycles at 45 cycles per minute. A cycle shall be full flex and twisting action.
(2) Anisotropic materials shall be tested in both machine and transverse directions.

6-1.4 Abrasion Procedure for Garment Materials. Specimens shall be abraded in accordance with ASTM D 4157, *Standard Test Method for Abrasion Resistance of Textile Fabrics (Oscillatory Cylinder Method)* under the following conditions:

(1) A 2.3 kg (5 lb) tension weight shall be used.
(2) A 1.6 kg (3.5 lb) head weight shall be used.
(3) The abradant shall be silicone carbide, ultrafine, 600 grit.
(4) The specimen shall be abraded for 25 continuous cycles.

6-1.5 Flexural Fatigue Procedure for Gloves. Specimen gloves shall be subjected to one full cycle of testing for dexterity testing as specified in Section 6-13 of this standard.

6-1.6 Flexural Fatigue Procedure for Footwear. Specimen footwear shall be subjected to 100,000 flexes in accordance with Footwear Industries of America Standard 1209, *Whole Shoe Flex*.

6-1.7 Fatigue Procedure for Suit Closure Assemblies. Specimen suit closure assemblies shall be exercised a total of 50 openings and 50 closings.

6-1.8 Dry Environment Conditioning Procedure for Garment and Glove Materials.

6-1.8.1 Specimens shall be conditioned at a temperature of 24°C, ±3°C (75°F, ±5°F) and a relative humidity of 45 percent, ±5 percent until equilibrium is reached as determined in accordance with Section 4 of Federal Test Method Standard 191A, *Textile Test Methods*, or for at least 24 hours, whichever is shortest.

6-1.8.2 Specimens shall be tested within 5 minutes after removal from conditioning.

6-2 Liquidtight Integrity Test One.

6-2.1 Application.

6-2.1.1 This test method shall apply to garments, nonencapsulating ensembles, and encapsulating ensembles.

6-2.1.2 Modifications to this test method for testing nonencapsulating ensembles shall be as specified in 6-2.8.

6-2.1.3 Modifications to this test method for testing encapsulating ensembles shall be as specified in 6-2.9.

6-2.2 Specimens.

6-2.2.1 A minimum of three specimens shall be tested. Specimens shall consist of the entire garment or ensemble with all layers assembled that are required for the garment to be compliant.

6-2.2.2 The size of the garment or ensemble comprising the specimens shall be chosen to conform with the dimensions of the mannequin for proper fit of the specimen on the mannequin in accordance with the manufacturer's sizing system. The size of the garments comprising the specimens shall be the same size as the mannequin in terms of chest circumference, waist circumference, and inseam height.

6-2.3 Sample Preparation.

6-2.3.1 Samples for conditioning shall be complete garments or ensembles.

6-2.3.2 Specimens shall be conditioned as specified in 6-1.2.

6-2.4 Apparatus.

6-2.4.1 The apparatus and supplies for testing shall be those specified in ASTM F 1359, *Standard Test Method for Measuring Liquid Penetration Resistance of Protective Clothing or Protective Ensembles Under a Shower Spray While on a Mannequin*, using the following modifications:

(1) The surface tension of the water used in testing shall be 32 dynes/cm, ±2 dynes/cm.
(2) The mannequin used in testing shall have straight arms and legs, with one arm positioned at the mannequin's side and the other arm bent at the elbow upward at a 45 degree angle.

6-2.5 Procedure.

6-2.5.1 Liquidtight integrity testing of garments shall be conducted in accordance with ASTM F 1359, *Standard Test Method for Measuring Liquid Penetration Resistance of Protective Clothing or Protective Ensembles Under a Shower Spray While on a Mannequin*, with the following modifications:

(1) No provisions for garments with a partial barrier layer shall be allowed.
(2) The method used for mounting the mannequin in the spray chamber shall not interfere with the water spray.
(3) The suited mannequin shall be exposed to the liquid spray for a total of 20 minutes, 5 minutes in each of the four specified mannequin orientations.
(4) At the end of the liquid spray exposure period, excess liquid shall be removed from the surface of the specimen.
(5) The specimen shall be inspected within 10 minutes of the end of the liquid spray exposure period for evidence of liquid penetration.

6-2.6 Report. A diagram shall be prepared for each test that identified the locations of any liquid leakage as detected on the liquid-absorptive garment.

6-2.7 Interpretation. Any evidence of liquid on the liquid-absorptive garment, as determined by visual, tactile, or absorbent toweling, shall constitute failure of the specimen.

6-2.8 Specific Requirements for Testing Nonencapsulating Ensembles.

6-2.8.1 Where nonencapsulating ensembles are tested, those portions of the body not covered by the ensemble shall be blocked off and shall not be evaluated for liquidtight integrity.

6-2.8.2 The technique used for blocking off portions of the garment shall not cover any seams and shall not extend beyond any edge of the garment more than 25 mm (1 in.).

6-2.9 Specific Requirements for Testing Encapsulating Ensembles.

6-2.9.1 Where encapsulating ensembles are tested, all areas of the mannequin body shall be evaluated for liquidtight integrity.

6-2.9.2 If outer gloves are worn in conjunction with gloves attached to the totally encapsulating ensemble or if outer boots are worn in conjunction with garment booties to meet foot protection requirements, these items shall not collect liquid.

6-3 Overall Garment Function and Integrity Test.

6-3.1 Application.

6-3.1.1 This test method shall apply to garments, nonencapsulating ensembles, and encapsulating ensembles.

6-3.1.2 Modifications to this test method for testing nonencapsulating and encapsulating ensembles shall be as specified in 6-3.7.

6-3.2 Specimens.

6-3.2.1 A minimum of one garment or ensemble shall be evaluated.

6-3.2.2 The test specimen shall include all outer wear and other items required for the garment or ensemble to be compliant with this standard.

6-3.3 Sample Preparation.

6-3.3.1 Samples for conditioning shall be complete garments.

6-3.3.2 Specimens shall be conditioned as specified in 6-1.2.

6-3.4 Procedure.

6-3.4.1 Garment overall function and integrity shall be measured in accordance with ASTM F 1154, *Standard Practices for Qualitatively Evaluating the Comfort, Fit, Function, and Integrity of Chemical Protective Suit Ensembles*, with the following parameters:

(a) Exercise Procedures A shall be used.

(b) Garments tested shall meet the sizing range of the test subject as determined in 3-3.4. The garment shall be donned in accordance with the manufacturer's instructions.

(c) Testing shall be conducted at 25°C, ±7°C (77°F, ±10°F) and relative humidity of 50 percent, ±20 percent.

(d) Liquidtight integrity shall be measured as specified in Section 6-2. Liquidtight integrity shall only be measured after the exercise procedures are completed.

(e) Where hoods are provided, a determination shall be made that the garment is designed to at least accommodate head protection devices meeting the dimensional requirements of Type I, Class G helmets of ANSI Z89.1, *Standard for Industrial Head Protection.*

(f) Where hoods with visors are provided, the test subject shall have a minimum visual acuity of 20/20 in each eye, uncorrected or corrected with contact lenses, as determined in a visual acuity test or doctor's examination.

(g) Appropriate underclothing and an open-circuit self-contained breathing apparatus (SCBA) shall be worn. For consistency in testing, the SCBA shall be compliant with NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus for the Fire Service.*

6-3.4.2 Where hoods with visors are provided, visual acuity testing within the suit shall be conducted using a standard 20-foot eye chart with a normal lighting range of 100–150 ft-candles at the chart and with the test subject positions at a distance of 6.1 m (20 ft) from the chart.

6-3.4.3 Where hoods with visors are provided, the test subject shall then read the standard eye chart through the lens of the SCBA facepiece and garment visor to determine the test subject's visual acuity.

6-3.4.4 Where a protective flap is used over the closure system, the test observer shall note whether the flap remains over the closure during Exercise Procedures A.

6-3.4.5 Where a protective flap is used over the closure system, any disengagement of the closure flap that exposes the closure shall be reported as the closure not remaining closed.

6-3.4.6 Where a protective flap is used over the closure system, any report of the closure not remaining closed shall constitute failure of the test.

6-3.5 Report.

6-3.5.1 A diagram shall be prepared for each test that identified the locations of any liquid leakage as detected on the liquid-absorptive garment.

6-3.5.2 The ability of the test subject to satisfactorily complete all exercises shall be reported.

6-3.5.3 Where hoods are provided, the garment accommodation of head protection meeting the dimensional requirements of Type I, Class G helmets of ANSI Z89.1, *Standard for Industrial Head Protection*, shall be reported.

6-3.5.4 Where hoods with visors are provided, the visual acuity of the test subject when in and out of the suit shall be reported.

6-3.6 Interpretation.

6-3.6.1 Any evidence of liquid on the liquid-absorptive garment shall constitute failing performance.

6-3.6.2 The inability of the test subject to satisfactorily complete all exercises within 15 minutes shall constitute failing performance.

6-3.6.3 Where hoods are provided, the non-accommodation of head protection meeting the dimensional requirements of Type I, Class G helmets of ANSI Z89.1, *Standard for Industrial Head Protection*, by the liquid splash-protective suit shall constitute failing performance.

6-3.6.4 Where hoods with visors are provided, the visual acuity of the test subject inside the suit shall be used for determining pass/fail.

6-3.7 Specific Requirements for Testing Nonencapsulating and Encapsulating Ensembles.

6-3.7.1 Garment overall function and integrity shall be measured in accordance with ASTM F 1154, *Standard Practices for Qualitatively Evaluating the Comfort, Fit, Function, and Integrity of Chemical Protective Suit Ensembles*, using both Procedure A and Procedure B.

6-3.7.2 Testing shall be performed as specified in 6-3.2 through 6-3.3.

6-4 Chemical Penetration Resistance Test.

6-4.1 Application.

6-4.1.1 This test method shall apply to garment materials, garment seams, visor materials, glove materials, and footwear materials.

6-4.1.2 Modifications to this test method for testing visor materials without abrading or flexing shall be as specified in 6-4.7.

6-4.1.3 Modifications to this test method for testing garment materials after flexing and abrading shall be as specified in 6-4.8.

6-4.1.4 Modifications to this test method for testing glove materials after flexing and abrading shall be as specified in 6-4.9.

6-4.1.5 Modifications to this test method for testing footwear materials after flexing and abrading shall be as specified in 6-4.10.

6-4.1.6 Modifications to this test method for testing seams shall be as specified in 6-4.11.

6-4.2 Specimens.

6-4.2.1 A minimum of three specimens shall be tested.

6-4.2.2 For composite materials, only the chemical protection layer shall be tested for chemical penetration resistance.

6-4.3 Sample Preparation. Specimens shall be conditioned as specified in 6-1.2.

6-4.4 Procedure.

6-4.4.1 Penetration resistance shall be measured in accordance with ASTM F 903, *Standard Test Method for Resistance of Protective Clothing Materials to Penetration by Liquids*, Procedure C using the following modifications:

(a) All tests shall be conducted at 25°C, ±3°C (77°F, ±5°F) and 65 percent, ±5 percent relative humidity.

(b) The plexiglass shield shall be omitted from the test cell.

(c) Use of blotting paper at the end of the test shall be permitted to assist in the visual observation of liquid penetration. Visual observed chemical on the blotting paper shall constitute failure of this test.

(d) An observation to determine specimen penetration shall be made at the end of the chemical contact period.

6-4.5 Report. The report shall include the pass/fail results for each chemical tested and an identification of location where penetration occurs, if discernible.

6-4.6 Interpretation. Observed liquid penetration at the end of the test for any specimen shall constitute failure of this test.

6-4.7 Specific Requirements for Testing Visor Materials.

6-4.7.1 Samples for conditioning shall be visor material(s).

6-4.7.2 Penetration testing shall be conducted against the following liquid chemicals:

(1) Acetone
(2) Acetonitrile
(3) Ethyl acetate
(4) Hexane
(5) 50 percent w/w sodium hydroxide
(6) 93.1 percent w/w sulfuric acid
(7) Tetrahydrofuran

6-4.8 Specific Requirements for Testing Garment Materials After Flexing and Abrading.

6-4.8.1 Samples for conditioning shall be 200 mm × 280 mm (8 in. × 11 in.) rectangles.

6-4.8.2 Samples shall first be conditioned by flexing as specified in 6-1.3. Following flexing, three samples for abrasion conditioning, each measuring 45 mm × 230 mm ($1^3/_4$ in. × 9 in.), shall be cut from the center of the flexed sample. At least one specimen for abrasion conditioning shall be taken from a sample flexed in the machine direction, and at least one specimen for abrasion conditioning shall be taken from a sample flexed in the cross machine direction for each chemical tested.

6-4.8.3 The new samples shall then be conditioned by abrading as specified in 6-1.4. Following abrasion, only one specimen for penetration resistance testing shall be taken from each sample subjected to abrasion. The penetration test specimen shall be taken from the exact center of the abraded sample so that the center of the penetration test and the center of the abraded sample coincide.

6-4.8.4 Penetration testing shall be conducted against the following liquid chemicals:

(1) Acetone
(2) Acetonitrile
(3) Ethyl acetate
(4) Hexane
(5) 50 percent w/w sodium hydroxide
(6) 93.1 percent w/w sulfuric acid
(7) Tetrahydrofuran

6-4.9 Specific Requirements for Testing Glove Materials After Flexing and Abrading.

6-4.9.1 Samples for conditioning shall be whole gloves.

6-4.9.2 Samples shall first be conditioned by flexing as specified in 6-1.5. Following flexing, a new sample shall be cut from the gauntlet portion of the flexed sample that measures 45 mm × 230 mm ($1^7/_8$ in. × 9 in.).

6-4.9.3 The new samples shall then be conditioned by abrading as specified in 6-1.4. Following abrasion, only one specimen for penetration resistance testing shall be taken from each sample subjected to abrasion. The penetration test specimen shall be taken from the exact center of the abraded sample so that the center of the penetration test and the center of the abraded sample coincide.

6-4.9.4 Penetration testing shall be conducted against the following liquid chemicals:

(1) Acetone
(2) Acetonitrile
(3) Ethyl acetate
(4) Hexane
(5) 50 percent w/w sodium hydroxide
(6) 93.1 percent w/w sulfuric acid
(7) Tetrahydrofuran

6-4.10 Specific Requirements for Testing Footwear Materials After Flexing and Abrading.

6-4.10.1 This test shall apply to all types of footwear configurations. If the footwear incorporates a bootie constructed of garment material, the garment material flex fatigue resistance test may be substituted for this test.

6-4.10.2 Samples for conditioning shall be whole footwear items.

6-4.10.3 Samples shall first be conditioned by flexing as specified in 6-1.6. Following flexing, new samples shall be taken in areas from the footwear upper where the greatest flexing occurred, usually at the footwear quarter or vamp, measuring 45 mm × 230 mm ($1^7/_8$ in. × 9 in.).

6-4.10.4 The new samples shall then be conditioned by abrading as specified in 6-1.4. Following abrasion, only one specimen for penetration resistance testing shall be taken from each sample subjected to abrasion. The penetration test specimen shall be taken from the exact center of the abraded sample so that the center of the penetration test and the center of the abraded sample coincide.

6-4.10.5 Penetration testing shall be conducted against the following liquid chemicals:

(1) Acetone
(2) Acetonitrile
(3) Ethyl acetate
(4) Hexane
(5) 50 percent w/w sodium hydroxide
(6) 93.1 percent w/w sulfuric acid
(7) Tetrahydrofuran

6-4.11 Specific Requirements for Testing Garment or Glove Seams.

6-4.11.1 Samples for conditioning shall be 610 mm (24 in.) lengths of prepared seam or cut from vapor-protective ensembles.

6-4.11.2 Seam specimens shall be prepared from seam samples that have a minimum of 75 mm (3 in.) of material on each side of the seam center. Penetration test specimens shall be cut such that the exact seam center divides the specimen in half.

6-4.11.3 Seam specimens shall be prepared representing or shall be taken from each different type of seam found in the garment, including as a minimum the garment to garment material seams and the garment to visor material seams.

6-4.11.4 Seams specimens shall be taken from gloves from the gauntlet portion of the glove when an external seam is used in the construction of the glove.

6-4.11.5 Penetration testing shall be conducted against 100 percent isopropanol and 93.1 percent w/w sulfuric acid.

6-5 Burst Strength Test.

6-5.1 Application. This test shall apply to garment and visor materials. If the garment or visor is constructed of several separable layers, then all layers, assembled in the order in which they appear in the garment or visor, shall be tested as a composite.

6-5.2 Specimens. A total of 10 specimens shall be tested.

6-5.3 Sample Preparation.

6-5.3.1 Specimens shall be conditioned as specified in 6-1.2.

6-5.3.2 Samples for conditioning shall be at least 305-mm (12-in.) squares of material.

6-5.4 Procedure.

6-5.4.1 Specimens shall be tested in accordance with Section 18.2, Tensile Testing Machine with Ring Clamp, in ASTM D 751, *Standard Test Methods for Coated Fabrics,* using the tension testing machine with ring clamp.

6-5.5 Report.

6-5.5.1 The burst strength of each specimen shall be reported to the nearest 1 N (0.25 lbf).

6-5.5.2 The average burst strength of all specimens shall be calculated and reported.

6-5.6 Interpretation. The average burst strength shall be used to determine pass/fail performance.

6-6 Puncture Propagation Tear Resistance Test.

6-6.1 Application. This test shall apply to garment and visor materials. If the protective garment is constructed of several layers, then all layers, assembled in the order in which they appear in the garment, shall be tested as a composite.

6-6.2 Specimens.

6-6.2.1 A minimum of five specimens in each of the warp directions, machine and coarse, and each of the filling directions, cross-machine and wales, shall be tested.

6-6.2.2 If the material is nonanisotropic, then 10 specimens shall be tested.

6-6.3 Sample Preparation.

6-6.3.1 Specimens shall be conditioned as specified in 6-1.2.

6-6.3.2 Samples for conditioning shall be at least 1-m (1-yd) squares of material.

6-6.4 Procedure. Specimens shall be tested in accordance with ASTM D 2582, *Standard Test Method for Puncture Propagation Tear Resistance of Plastic Film and Thin Sheeting.*

6-6.5 Report.

6-6.5.1 The puncture propagation tear resistance of each specimen shall be reported to the nearest 0.445 N (0.1 lbf).

6-6.5.2 An average puncture propagation tear resistance shall be calculated for warp and filling directions.

6-6.6 Interpretation.

6-6.6.1 Pass/fail performance shall be based on the average puncture propagation tear resistance in the warp direction and filling direction.

6-6.6.2 Failure in any one direction constitutes failure for the material.

6-7 Cold Temperature Performance Test One.

6-7.1 Application. This test method shall apply to garment and glove materials.

6-7.2 Specimens.

6-7.2.1 A minimum of five specimens in each of the warp directions, machine and coarse, and each of the filling directions, cross-machine or wales, shall be tested.

6-7.2.2 If the material is isotropic, then 10 specimens shall be tested.

6-7.3 Sample Preparation.

6-7.3.1 Specimens shall be conditioned as specified in 6-1.2.

6-7.3.2 Samples for conditioning shall be at least 1-m (1-yd) squares of material.

6-7.4 Procedure.

6-7.4.1 Specimens shall be tested in accordance with ASTM D 747, *Standard Test Method for Apparent Bending Modulus of Plastics by Means of a Cantilever Beam,* with the following modifications:

(a) The test temperature shall be −25°C (−13°F).

(b) The bending moment shall be that applied when the specimen is bent to a 60-degree angular deflection and shall be calculated in inch-pounds as follows:

$$\text{Bending moment} = \frac{\text{load scale reading} \times \text{moment weight}}{100}$$

$$\text{Bending moment (Nm)} = \text{bending moment, in.-lb} \times 0.113$$

6-7.5 Report. Cold temperature performance results shall be reported as the average for each material direction.

6-7.6 Interpretation. Failure of the material in any direction shall constitute failing performance.

6-8 Seam/Closure Breaking Strength Test.

6-8.1 Application.

6-8.1.1 This test shall be applied to garment seams and the garment closure assembly used in the construction of the garment, including at least garment and garment-visor seams. Where the garment consists of multiple separable layers, then the test shall be applied to the seams and closure assemblies of each separable layer.

6-8.1.2 Modifications to this test method for testing seams shall be as specified in 6-8.7.

6-8.1.3 Modifications to this test method for testing closure assemblies shall be as specified in 6-8.8.

6-8.2 Specimens.

6-8.2.1 A minimum of five seam or closure assembly specimens representative of the garment shall be tested for each seam and closure assembly type.

6-8.2.2 A straight seam shall be cut from the finished garment or shall be permitted to be prepared by joining two pieces of the garment material.

6-8.3 Sample Preparation.

6-8.3.1 Specimens shall be conditioned as specified in 6-1.2.

6-8.3.2 Samples for conditioning shall be 610 mm (24 in.) lengths of seam.

6-8.4 Procedure. All seams and closure assemblies shall be tested in accordance with ASTM D 751, *Standard Test Methods for Coated Fabrics.*

6-8.5 Report.

6-8.5.1 The breaking strength for each seam or closure assembly specimen shall be reported. The average breaking strength for each seam or closure assembly type shall also be reported.

6-8.5.2 The types of seams and closure assemblies tested shall be reported as to whether the specimens were cut from the finished garment or prepared from fabric samples.

6-8.6 Interpretation. The average seam breaking strength for each seam type shall be used to determine pass/fail performance.

6-8.7 Specific Procedures for Testing Seams. Samples for conditioning shall include 150 mm (6 in.) of material on either side of the seam.

6-8.8 Specific Procedures for Testing Closure Assemblies.

6-8.8.1 Samples for conditioning shall include 150 mm (6 in.) of material on either side of the closure.

6-8.8.2 Specimens shall be conditioned as specified in 6-1.7.

6-9 Cold Temperature Performance Test Two.

6-9.1 Application. This test method shall apply to garment and glove materials.

6-9.2 Specimens. A minimum of five specimens shall be tested.

6-9.3 Sample Preparation.

6-9.3.1 Specimens shall be conditioned as specified in 6-1.2.

6-9.3.2 Samples for conditioning shall be at least 1-m (1-yd) squares of material.

6-9.4 Procedure.

6-9.4.1 Specimens shall be tested in accordance with ASTM D 2136, *Standard Test Method for Coated Fabrics — Low-Temperature Bend Test.*

6-9.4.2 Following this testing, specimens shall be examined for evidence of damage. Damage shall include any breakage, cracks, tears, or separation, but shall not include discoloration along the folded area.

6-9.5 Report. Observations of visible damage shall be reported for each specimen.

6-9.6 Interpretation.

6-9.6.1 Damage of any one specimen shall constitute failing performance.

6-9.6.2 Rigid visors that do not bend, but show no evidence of damage, shall still be considered to have passed the test.

6-10 Liquidtight Integrity Test Two.

6-10.1 Application.

6-10.1.1 This test method shall apply to gloves and footwear.

6-10.1.2 Modifications to this test method for testing gloves shall be as specified in 6-10.7.

6-10.1.3 Modifications to this test method for testing footwear shall be as specified in 6-10.8.

6-10.2 Specimens.

6-10.2.1 A minimum of 10 specimens shall be tested.

6-10.2.2 Specimens shall consist of the entire glove or footwear item with all layers assembled that are required for the garment to be compliant.

6-10.3 Sample Preparation.

6-10.3.1 Samples for conditioning shall be whole gloves or footwear.

6-10.3.2 Specimens shall be conditioned as specified in 6-1.2.

6-10.4 Procedure.

6-10.4.1 Liquidtight integrity testing of gloves and footwear shall be conducted in accordance with ASTM D 5151, *Standard Test Method for Detection of Holes in Medical Gloves*, with the following modifications:

(1) The surface tension of the water used in testing shall be 32 dynes/cm, ±2 dynes/cm.
(2) The surfactant-treated water shall remain in the specimen for a period of 1 hour, +5/−0 min.
(3) Observations for leakage shall be performed at the end of the test period.
(4) Blotting paper shall be permitted to be used for assisting in the determination that liquid leakage has occurred.

6-10.5 Report. Observations of water leakage shall be noted by specific area on the test specimen.

6-10.6 Interpretation. Any evidence of water leakage, as determined by visual, tactile, or absorbent blotting, shall constitute failure of the specimen.

6-10.7 Specific Requirements for Testing Gloves.

6-10.7.1 Specimens shall be conditioned as specified in 6-1.5.

6-10.7.2 A sufficient amount of surfactant-treated water shall be added to the specimen so that the water is within 25 mm (1 in.) of the edge of the glove opening.

6-10.8 Specific Requirements for Testing Footwear.

6-10.8.1 Specimens shall be conditioned as specified in 6-1.6.

6-10.8.2 A sufficient amount of surfactant-treated water shall be added to the specimen so that the water is within 25 mm (1 in.) of the edge of the footwear opening.

6-11 Cut Resistance Test.

6-11.1 Application.

6-11.1.1 This test method shall apply to glove and footwear upper materials.

6-11.1.2 Modifications to this test method for evaluation of glove materials shall be as specified in 6-11.7.

6-11.1.3 Modifications to this test method for evaluation of footwear upper materials shall be as specified in 6-11.8.

6-11.2 Specimens. A minimum of three specimens consisting of all layers shall be tested.

6-11.3 Sample Preparation.

6-11.3.1 Samples for conditioning shall be whole gloves or footwear uppers.

6-11.3.2 Specimens shall be conditioned as specified in 6-1.2.

6-11.4 Procedure. Specimens shall be evaluated in accordance with ASTM F 1790, *Standard Test Methods for Measuring Cut Resistance of Materials Used in Protective Clothing*, with the modification that specimens shall be tested to a specific load with the measurement of cut distance.

6-11.5 Report.

6-11.5.1 The cut distance shall be reported to the nearest 1 mm (0.05 in.) for each sample specimen.

6-11.5.2 The average cut distance in mm (in.) shall be reported for all specimens tested.

6-11.6 Interpretation. The average cut force shall be used to determine pass/fail performance.

6-11.7 Specific Requirements for Testing Glove Materials.

6-11.7.1 Specimens shall be taken from the back and palm of the glove and shall not include seams.

6-11.7.2 Cut resistance testing shall be performed under a load of 200 g (7 oz).

6-11.8 Specific Requirements for Testing Footwear Upper Materials.

6-11.8.1 Specimens shall be taken from the parts of the footwear upper that provide uniform thickness and shall not include seams.

6-11.8.2 Cut resistance testing shall be performed under a load of 400 g (14 oz.).

6-12 Puncture Resistance Test One.

6-12.1 Application.

6-12.1.1 This test shall be applied to glove and footwear upper materials.

6-12.1.2 Modifications to this test method for testing glove materials shall be as specified in 6-12.7.

6-12.1.3 Modifications to this test method for testing footwear upper material shall be as specified in 6-12.8.

6-12.2 Specimens.

6-12.2.1 A minimum of three specimens consisting of all layers and measuring as at least 150-mm (6-in.) squares shall be tested.

6-12.3 Sample Preparation.

6-12.3.1 Samples for conditioning shall be complete gloves or footwear upper sections.

6-12.3.2 Specimens shall be tested after conditioning as specified in 6-1.2.

6-12.4 Procedure. Specimens shall be tested in accordance with ASTM F 1342, *Standard Test Method for Resistance of Protective Clothing Materials to Puncture.*

6-12.5 Report.

6-12.5.1 The puncture force shall be reported for each specimen to the nearest 50 g (2 oz) of force.

6-12.5.2 The average puncture force shall be reported for all specimens tested.

6-12.6 Interpretation. The average puncture force shall be used to determine pass/fail performance.

6-12.7 Specific Requirements for Testing Glove Materials.

6-12.7.1 Specimens shall consist of each composite of the palm, palm side of the fingers, and back of the glove used in actual suit glove configuration, with layers arranged in the proper order.

6-12.7.2 Where the specimen composites of the palm, palm side of the fingers, and back of the glove are identical, only one representative composite shall be required to be tested.

6-12.8 Specific Requirements for Testing Footwear Upper Materials.

6-12.8.1 Specimens shall consist of each composite of the footwear item used in the actual suit footwear configuration, with layers arranged in proper order.

6-12.8.2 Specimens shall be taken from the thinnest portion of the footwear upper.

6-13 Glove Hand Function Test.

6-13.1 Application. This test shall apply to gloves.

6-13.2 Specimens.

6-13.2.1 A minimum of one glove pair for each size provided with the suit shall be used for testing.

6-13.2.2 Each glove pair shall be tested as a complete set of gloves in new, as distributed, condition.

6-13.2.3 Glove pair specimens shall not receive special softening or flexing treatments prior to this test.

6-13.3 Sample Preparation.

6-13.3.1 Glove pair specimens shall be preconditioned as specified in 6-1.2.

6-13.3.2 Samples for conditioning shall be whole glove pairs.

6-13.4 Procedures.

6-13.4.1 Each glove size shall be evaluated by a separate test subject.

6-13.4.2 Test subjects shall be selected such that their hand dimensions conform to the manufacturer's sizing information for the glove sizes being evaluated.

6-13.4.3 Each test subject shall be familiarized with the test apparatus and procedure by practicing the test three times before conducting actual testing, but not on the same day of the actual testing.

6-13.5 Pegboard Procedure.

6-13.5.1 A pegboard apparatus that consists of 25 stainless steel pins and a pegboard shall be used. Each stainless steel pin shall have a diameter of 9.5 mm ($^3/_8$ in.) and a length of 38 mm ($1^1/_2$ in.). The pegboard shall have 25 holes, each hole having a diameter of 10 mm ($^{13}/_{32}$ in.) and a depth of 13 mm ($^1/_2$ in.). The holes shall be a 5 by 5 pattern and each hole shall have a separation of 25 mm (1 in.) from any adjacent hole.

6-13.5.2 Before each test, the pegs and peg board shall be placed on the test surface which shall be a nominally 610 mm × 915 mm (24 in. × 36 in.) sheet of 1.6-mm (0.0625-in.) Neoprene having a hardness of 50, ±5 Shore A and a thickness of 1.57 mm (0.062 in.), ±10 percent. The pegs shall be randomly scattered in the working area most comfortable to the test subject (such as on the right side for right-handed subjects, left side of left-handed test subjects, or directly in front of the subject).

6-13.5.3 In starting the test, each peg shall be grasped near its end and shall be placed in the peg board beginning at the upper left corner and proceeding from left-to-right and top-to-bottom. The pegs shall not be picked up from any surface other than the specified test surface, and shall not be picked up by sliding, standing, or otherwise supporting the peg with another object (such as the peg board, another peg, or the test subject's free hand). Only one hand shall be used during the test, and only one peg shall be grasped at a time. The test subject shall not alternate hands during the test series. The peg board shall be permitted to be prevented from moving during the test by the test subject's free hand or other means as necessary.

6-13.5.4 The dexterity test time shall be the time it takes from grasping the first peg to placing the last peg in the pegboard.

6-13.5.5 Each test subject shall perform the test without gloves following the steps in 6-13.5.2 through 6-13.5.4 until the variance of the dexterity times of that person's last three repetitions does not exceed 8 percent. Variance shall be calculated by dividing the standard deviation by the average of three repetitions, and multiplying by 100. The average of the three repetitions shall be used as the baseline dexterity test time (DTT_b), and shall be between 25–45 seconds. The test shall be conducted without the test subject's knowledge of the dexterity test time for each repetition.

6-13.5.6 Each test subject shall then perform the test with one pair of gloves following the steps in 6-13.5.2 through 6-13.5.4 until the variance of the dexterity times of that person's fastest three repetitions does not exceed 8 percent. Variance shall be calculated as in 6-13.5.5. The average of the three fastest repetitions shall be used as the dexterity test time with gloves (DTT_g). The test shall be conducted without the test subject's knowledge of the dexterity test time for each repetition.

6-13.5.7 The dexterity test time with gloves shall be compared with the baseline dexterity test time for each test subject. The percent of bare-handed control shall be calculated for each glove size as follows:

$$\text{Percent of barehanded control} = \frac{DTT_g}{DTT_b} \times 100$$

where:

DTT_g = dexterity test time with gloves
DTT_b = baseline dexterity test time

6-13.6 Report. The average percent of barehanded control for all tests shall be calculated and reported.

6-13.7 Interpretation. The average percent of barehanded control for all tests shall be used to determine pass/fail performance.

6-14 Puncture Resistance Test Two.

6-14.1 Application. This test method shall apply to footwear soles.

6-14.2 Specimens. A minimum of three footwear soles shall be tested.

6-14.3 Sample Preparation.

6-14.3.1 Samples for conditioning shall be footwear sole sections.

6-14.3.2 Specimens shall be conditioned as specified in 6-1.2.

6-14.4 Procedure. Puncture resistance shall be performed in accordance with Section 3 of CSA Z195-M, *Standard for Protective Footwear, Occupational Health and Safety.*

6-14.5 Report. The force required to puncture the sole reinforcement device of each specimen shall be reported.

6-14.6 Interpretation. One or more footwear specimens failing this test shall constitute failing performance.

6-15 Abrasion Resistance Test.

6-15.1 Application. This test method shall apply to footwear soles.

6-15.2 Specimens. A minimum of three footwear soles shall be tested.

6-15.3 Sample Preparation.

6-15.3.1 Samples for conditioning shall be footwear soles.

6-15.3.2 Specimens shall be conditioned as specified in 6-1.2.

6-15.4 Procedure. Puncture resistance shall be performed in accordance with ASTM D 1630, *Standard Test Method for Rubber Property—Abrasion Resistance (NBS Abrader)*.

6-15.5 Report. The abrasion resistance rating of each specimen shall be reported.

6-15.6 Interpretation. One or more footwear specimens failing this test shall constitute failing performance.

6-16 Impact and Compression Test.

6-16.1 Application. This test method shall apply to the toe section of the footwear.

6-16.2 Specimens. A minimum of three footwear items shall be tested for both impact and compression.

6-16.3 Sample Preparation.

6-16.3.1 Samples for conditioning shall be complete footwear toes.

6-16.3.2 Specimens shall be conditioned as specified in 6-1.2.

6-16.4 Procedure. Footwear specimens shall be tested in accordance with Section 1.4 of ANSI Z41, *Standard for Safety-Toe Footwear.*

6-16.5 Report. The impact and compression forces for each specimen shall be reported.

6-16.6 Interpretation. One or more footwear specimens failing this test shall constitute failing performance.

6-17 Ladder Shank Bend Resistance Test.

6-17.1 Application. This test method shall apply to footwear ladder shanks.

6-17.2 Specimens. A minimum of three footwear ladder shanks shall be tested.

6-17.3 Sample Preparation.

6-17.3.1 Samples for conditioning shall be footwear ladder shanks.

6-17.3.2 Specimens shall be conditioned as specified in 6-1.2.

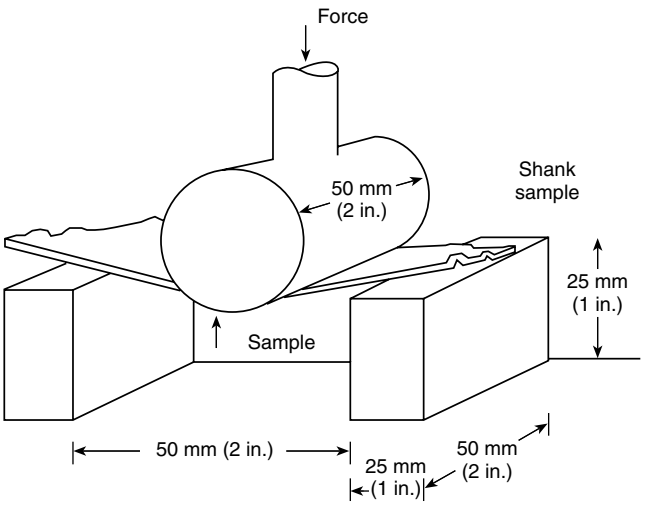
6-17.4 Apparatus.

6-17.4.1 The apparatus shall consist of a tensile testing machine, such as an Instron or equivalent, that challenges a specimen with a simulated ladder rung.

6-17.4.2 A 32 mm diameter × 50 mm long ($1^1/_4$ in. diameter × 2 in. long) noncompressible probe shall be mounted on the movable arm.

6-17.4.3 The specimen support assembly shall consist of two 50 mm × 25 mm × 25 mm (2 in. × 1 in. × 1 in.) noncompressible blocks placed 50 mm (2 in.) apart as shown in Figure 6-17.4.3

FIGURE 6-17.4.3 Ladder shank bend test set-up.



6-17.5 Procedure. The ladder shank shall be placed on mounting blocks as it would be oriented toward the ladder when affixed into the protective footwear and subjected to force on its center with the test probe operated at 50 mm/min (2 in./min).

6-17.6 Report.

6-17.6.1 Deflection at 182.0 kg (400 lb) shall be reported to the nearest 1 mm ($^3/_{64}$ in.).

6-17.6.2 The average deflection shall be calculated and reported to the nearest 1 mm ($^3/_{64}$ in.).

6-17.7 Interpretation. Pass/fail performance shall be determined using the average deflection for all specimens tested.

6-18 Slip Resistance Test.

6-18.1 Application. This test method shall apply to footwear soles.

6-18.2 Specimens. A minimum of three complete footwear items shall be tested.

6-18.3 Sample Preparation.

6-18.3.1 Samples for conditioning shall be footwear.

6-18.3.2 Specimens shall be conditioned as specified in 6-1.2.

6-18.4 Procedure.

6-18.4.1 Slip resistance shall be performed in accordance with ASTM F 489, *Standard Test Method for Static Coefficient of Friction of Shoe Sole and Heel Materials as Measured by the James Machine* in a dry condition.

6-18.5 Report. The static coefficient of friction under both dry and wet conditions of each specimen shall be reported.

6-18.6 Interpretation. One or more footwear specimens failing this test shall constitute failing performance.

6-19 Overall Ensemble Flash Test.

6-19.1 Application. This test method shall apply to complete liquid splash-protective ensembles, garments, gloves, and footwear.

6-19.2 Specimens.

6-19.2.1 A minimum of one specimen shall be tested.

6-19.2.2 Additional protective clothing components and equipment that are necessary to provide flash protection to the wearer shall be tested in conjunction with the liquid splash-protective clothing or ensemble.

6-19.3 Sample Preparation.

6-19.3.1 Samples for conditioning shall be complete liquid splash-protective ensembles, full garments, gloves, or footwear.

6-19.3.2 Specimens shall be conditioned as specified in 6-1.2.

6-19.4 Apparatus.

6-19.4.1 A human form mannequin shall be used to support the protective suit during chemical flash fire testing. The mannequin shall be coated with a suitable flame-retardant coating.

6-19.4.2 A one-piece flame-resistant coverall shall be placed over the mannequin.

6-19.4.3 The garment, gloves, and footwear to be tested shall be placed on the mannequin, over the flame-resistant clothing, in accordance with the manufacturer's instructions.

6-19.4.4 A flash chamber shall be constructed as illustrated in Figure 6-19.4.4 and shall include the following:

(a) It shall have an internal width and depth of 1.83 m, ±100 mm (6 ft, ±4 in.) and a height of 2.44 m, ±100 mm (8 ft, ±4 in.).

(b) It shall be constructed of 50 mm × 100 mm (2 in. × 4 in.) framing lumber or other suitable structural material. Fire wall, 20 mm ($^3/_4$ in.), or other suitable flame-resistant paneling shall be used on the opposite two walls of the chamber. A piece of 13-mm ($^1/_2$-in.) heat-tempered safety glass shall be used on the remaining walls for multiple viewing points during testing. At least one of the glass walls shall be attached by a means that allows for easy removal of the mannequin. Both glass walls shall be configured to achieve gastight seals with the chamber.

(c) All fire wall seams shall be taped and the interior walls of the chamber coated with a suitable flame-retardant material.

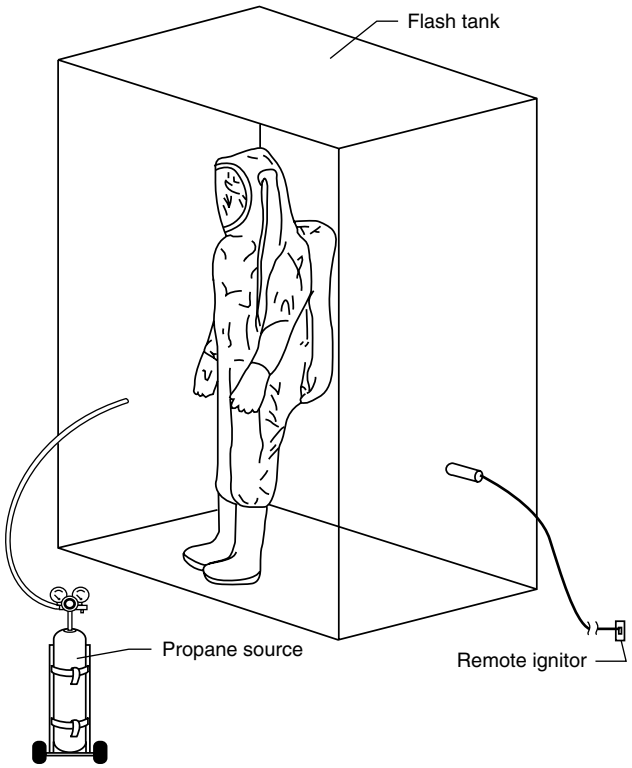
(d) It shall have a port for filling the chamber with propane gas located as shown in Figure 6-19.4.4. The port shall allow isolation of the propane source through a valve. The port shall be leakfree with respect to the outside environment.

(e) It shall have two ports for electric ignitors located as showing in Figure 6-19.4.4. The port shall be leakfree with respect to the outside environment.

(f) It shall have a top that allows containment of propane gas within the chamber during filling and venting of flash pressure after ignition.

(g) A suitable stand should be constructed that allows the mannequin to be positioned 305 mm, ±25 mm (12 in., ±1 in.) above the chamber floor shall be constructed.

FIGURE 6-19.4.4 Overall ensemble chemical flash chamber.



6-19.5 Procedure.

6-19.5.1 The suited mannequin shall be placed on the stand in the center of the flash chamber in an upright stationary position.

6-19.5.2 Propane gas at 99 percent purity or better shall be metered into the chamber at a delivery pressure of 172.3 kPa, ±13.8 kPa (25 psi, ±2 psi) and rate of 0.16 m^3/min, ±0.01 m^3/min (5.5 ft^3/min, ±0.5 ft^3/min). The concentration of propane within the chamber shall be sufficient to produce a visible chemical flash fire lasting 7 seconds, ±1 second. The concentration of the propane shall be permitted to be checked by a combustible gas meter or similar detector.

6-19.5.3 The flash chamber shall be viewed at both vantage points, front and back, throughout the test. Video documentation shall also be conducted from the front vantage point.

6-19.5.4 The chamber atmosphere shall be remotely ignited at 30 seconds, ±5 seconds after the chamber has been filled with propane gas.

6-19.5.5 The suited mannequin shall not be removed until all surfaces have cooled to ambient temperature.

6-19.5.6 The protective clothing or ensemble shall be removed from the mannequin and examined visually for signs of physical damage from thermal exposure.

6-19.5.7 A liquidtight integrity test shall be performed on the protective clothing or ensemble in accordance with Section 6-2 after the chemical flash fire exposure.

6-19.5.8 Following liquidtight integrity testing, the suit shall be donned by a test subject and evaluated as follows:

(a) The test subject shall have a minimum visual acuity of 20/20 in each eye, uncorrected or corrected with contact lenses, as determined in a visual acuity test or doctor's examination.

(b) Visual acuity testing within the suit shall be conducted using a standard 20-foot eye chart with a normal lighting range of 100–150 ft-candles at the chart and with the test subject positions at a distance of 6.1 m (20 ft) from the chart.

(c) The test subject shall then read the standard eye chart through the lens of the SCBA facepiece and suit visor to determine his or her visual acuity.

6-19.5.9 All testing shall be performed at a temperature of 24°C, ±11°C (75°F, ±20°F) and a relative humidity of 70 percent, ±25 percent. Tests shall not be conducted outdoors during precipitation.

6-19.6 Report.

6-19.6.1 The post-flash exposure liquidtight integrity test result, afterflame time, and visor clarity shall be reported for each test specimen.

6-19.6.2 An illustration of the protective clothing or ensemble as shown in Figure 6-19.6.2, shall be prepared and the location of any damage shall be shown. Separate illustrations shall be prepared for over covers if tested with the protective suit. Damage shall include, but not be limited to the following:

(1) Charring
(2) Blistering
(3) Evidence of material melting
(4) Delamination
(5) Destruction of any suit components

6-19.7 Interpretation.

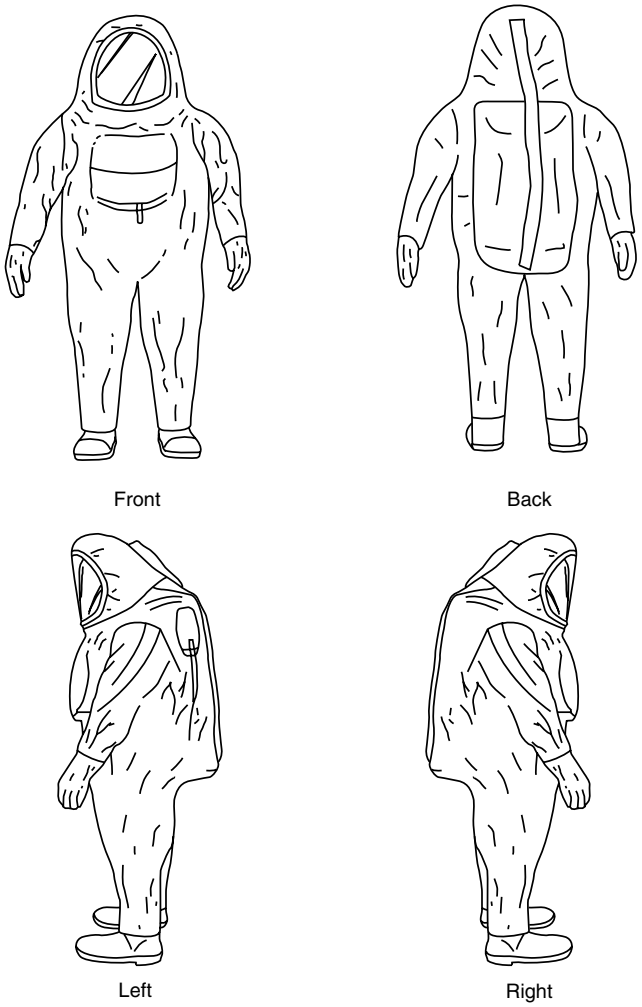
6-19.7.1 Any specimen with an afterflame time greater than 2 seconds shall constitute failing performance.

6-19.7.2 If the liquid is found on the inner liquid-absorptive garment following liquidtight integrity testing, the specimen fails the test.

6-19.7.3 The visual acuity of the test subject inside the suit shall be used for determining pass/fail.

6-19.8 Specific Requirements for Testing Garments, Gloves, and Footwear. Where garments, gloves, and footwear that do not cover the entire mannequin are tested, items of clothing constructed of flame-resistant materials shall be used to cover those exposed portions of the mannequin body in a manner that does not cover the item being evaluated.

FIGURE 6-19.6.2 Suit diagram (for noting damaged locations).



6-20 Thermal Protective Performance (TPP) Test.

6-20.1 Application. This test method shall apply to garment materials, glove materials, and footwear upper materials.

6-20.2 Specimens.

6-20.2.1 Thermal protective performance testing shall be conducted on three specimens. Specimens shall measure 6 in. × 6 in., $\pm 1/4$ in. (150 mm × 150 mm, ±6 mm) and shall consist of all layers representative of the clothing item to be tested.

6-20.3 Sample Preparation. Specimens shall be tested after preconditioning as specified in 6-1.2.

6-20.4 Apparatus.

6-20.4.1 The test apparatus shall consist of a specimen holder assembly, specimen holder assembly support, thermal flux source, protective shutter, sensor assembly, and recorder. The apparatus shall also have a gas supply, gas rotameter, burners, and sensor.

6-20.4.1.1 The specimen holder assembly shall consist of upper and lower mounting plates. Specimen holder maintaining plates shall be 200 mm × 200 mm, ±2 mm, × 6 mm,

±1 mm (8 in. × 8 in., $\pm^1/_{16}$ in. × $^1/_4$ in., $\pm^1/_{32}$ in.). The lower specimen mounting plate shall have centered a 100 mm × 100 mm, ±2 mm (4 in. × 4 in., $\pm^1/_{16}$ in.) hole. The upper specimen mounting plate shall have centered a 130 mm × 130 mm, ±2 mm ($5^1/_8$ in. × $5^1/_8$ in., $\pm^1/_{16}$ in.) hole. The lower specimen mounting plate shall have a 25 mm, ±2 mm high, × 3 mm, ±1 mm (1 in., $\pm^1/_{16}$ in. high, × $^1/_8$ in., $\pm^1/_{32}$ in.) thick steel post welded to each corner 6 mm, ±2 mm ($^1/_4$ in., $\pm^1/_{16}$ in.) from each side and perpendicular to the plane of the plate. The upper sample mounting plate shall have a corresponding hole in each corner so that the upper specimen mounting plate fits over the lower specimen mounting plate. The specifications for the lower specimen mounting plate shall conform to Figure 6-20.4.1.1.

FIGURE 6-20.4.1.1 Lower specimen mounting plate.

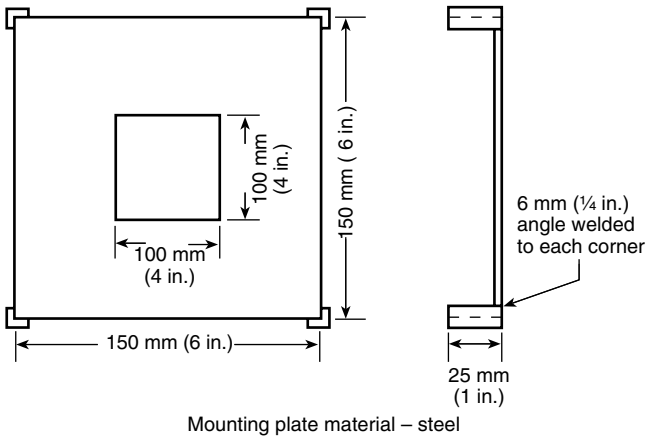
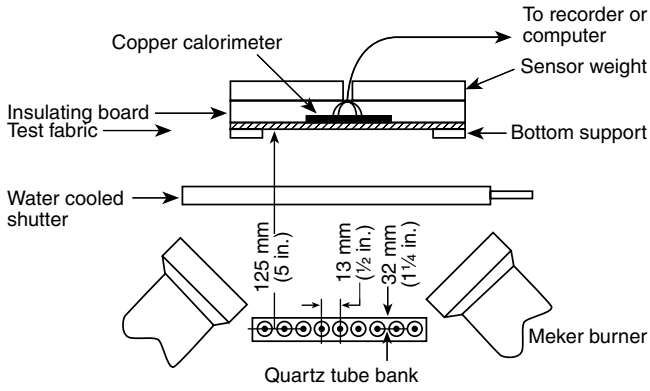


FIGURE 6-20.4.1.3 Specifications for TPP tester thermal flux source.



6-20.4.1.2 The specimen holder assembly support shall consist of a steel frame that rigidly holds and positions in a reproducible manner the specimen holder assembly and specimen relative to the thermal flux.

6-20.4.1.3 The thermal flux source shall consist of a convective thermal flux source and a radiant thermal flux source. The convective thermal flux source shall consist of two Meker or Fisher burners affixed beneath the specimen holder assembly opening and subtended at a nominal 45 degree angle from vertical so that the flames converge at a point immediately beneath the specimen. The radiant thermal flux source shall consist of nine quartz T-150 infrared tubes affixed beneath and centered between the burners as shown in Figure 6-20.4.1.3.

6-20.4.1.4 A protective shutter shall be placed between the thermal flux source and the specimen. The protective shutter shall be capable of completely dissipating thermal load from thermal flux source of the time periods before and after specimen exposure. The protective shutter shall be controlled by means of an automatic timer with a resolution of not less than 0.1 second.

6-20.4.1.5 The sensor assembly shall be fitted into the opening in the top plate of the specimen holder and shall be in contact with the surface of the thermal barrier normally facing the wearer. Sensor assembly shall consist of 133 mm × 133 mm × 13 mm ($5^1/_4$ in. × $5^1/_4$ in. × $^1/_2$ in.) heat-resistant block that fits without binding into the hole of the upper specimen mounting plate and shall be uniformly weighted such that complete sensor assembly, including copper calorimeters, weighs 1000 g, ±10 g (2.2 lb, ±0.4 oz).

6-20.4.1.6 The recorder shall be any strip chart recorder with full-scale deflection of at least 150°C (300°F) or 10 mV and sufficient sensitivity and scale divisions to read exposure time to ±0.1 second. Alternatively, an equivalent automated data acquisition system meeting or exceeding the sensitivity and accuracy requirements of the strip chart recorder shall be permitted to be used instead of a strip chart recorder.

6-20.4.1.7 The gas supply shall be liquid propane with appropriate reducer and valving arrangements to control the gas supply pressure at 54 kPa, ±14 kPa (8 psig, ±2 psig) and capable of providing flow equivalent to 2 L/min (0.07 ft^3/min) air at standard conditions.

6-20.4.1.8 The gas rotameter shall be any gas rotameter with range to give flow equivalent to 2 L/min (0.07 ft^3/min) air at standard conditions.

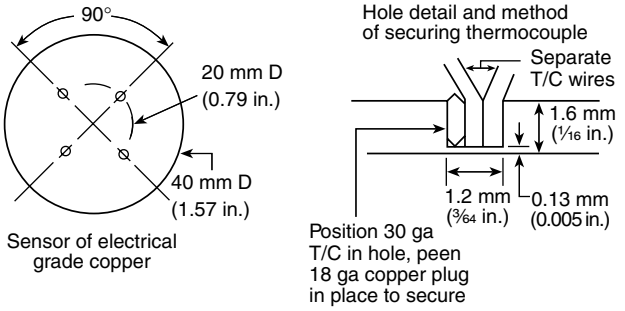
6-20.4.1.9 The burners shall be Meker or Fisher burners with 38-mm ($1^1/_2$-in.) diameter top and with orifice size of 1 mm ($^3/_{64}$ in).

6-20.4.1.10 The sensor shall be a copper calorimeter mounted in an insulating block. The calorimeter shall conform to the specifications provided in Figure 6-20.4.1.10.

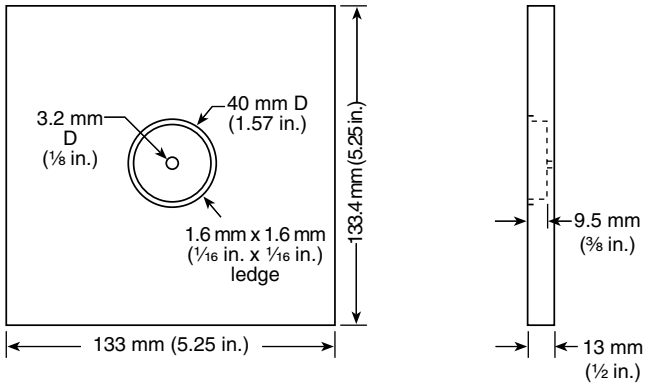
6-20.4.2 A radiometer shall be used in the calibration of the test apparatus.

6-20.4.2.1 The radiometer shall be a Gardon-type radiation transducer with a diameter of 25 mm (1 in.). The heat flux operating range shall be from 0 to 5 microns. The heat flux operating range shall be from 0 kW/m^2 to 60 kW/m^2 (0 cal/cm^2/sec to 1.4 cal/cm^2/sec or 0 Btu/ft^2/sec to 5 Btu/ft^2/sec). The radiometer shall be water cooled and the cooling water temperature shall be above the ambient dew point temperature.

FIGURE 6-20.4.1.10 Sensor assembly.



Details of calorimeter construction



Sensor support of soft insulation board

Connect 4 T/C in parallel, silver solder connections. Bring common lead out of center hole of support. Secure sensor into support with three or four sewing pins cut to 9.5 mm (3/8 in.) long.

6-20.5 Procedure.

6-20.5.1 General Procedures.

6-20.5.1.1 All testing and calibration shall be performed in a hood or ventilated area to carry away combustion products, smoke, or fumes. If air currents disturb the flame, the apparatus shall be shielded. Procedures for testing and calibration shall be performed using the same hood and ventilation conditions.

6-20.5.1.2 Care shall be exercised in handling the burner with open flame. Adequate separations shall be maintained between flame and combustible materials. Since the specimen holder and sensor assembly become heated during prolonged testing, protective gloves shall be used when handling these hot objects. Since some test specimens become hazardous when exposed to direct flame, care shall be used when the specimen ignites or releases combustible gases. If specimens ignite, the gas supply at the cylinder shall be shut off and the flame shall be allowed to burn the gas.

6-20.5.2 Calibration Procedure.

6-20.5.2.1 Specimens shall be exposed to a thermal flux of 83 kW/m^2, ±4 kW/m^2 (2.0 cal/cm^2/sec, ±0.1 cal/cm^2/sec) as measured with the copper calorimeter. The copper calorimeter shall be the only heat sensor used in setting the total 83 kW/m^2 (2.0 cal/cm^2/sec) exposure condition. The total heat flux shall be calculated directly and only from the voltage output of the thermocouples, using the measured temperature rise of the testing copper calorimeter, the area and mass of the calorimeter, and the heat capacity of copper to calibrate the heat flux. Other heat-sensing devices shall not be used to reference or adjust the total heat flux read by the copper calorimeter.

6-20.5.2.2 The total heat flux and the 50 percent/50 percent, ±5 percent radiant/convective balance of the energy sources shall be set in accordance with the procedures in 6-20.5.2.3 to 6-20.5.2.6. The level of the radiant heat flux shall be determined using a radiometer and the level of the total heat flux shall be determined by using a calibration copper calorimeter designated and used only to set the total exposure level.

6-20.5.2.3 Once an initial setting of 12 kW/m^2, ±4 kW/m^2 (0.3 cal/cm^2/sec, ±0.1 cal/cm^2/sec) has been made to the array of new quarter lamps, the operating voltage shall be reduced and permanently retained for testing purposes. During all future calibration procedures, the voltage setting of the quartz lamps shall be compared to the current voltage setting of the new quartz lamps, and if the voltage increase is 5 V or greater from the initial setting, the lamps shall be replaced.

6-20.5.2.4* The two Meker or Fisher burners shall be initially adjusted so that the flames converge upon each other just below the center of the radiometer. The color of the flame shall be primarily blue.

6-20.5.2.5 The radiant thermal flux of nine quartz infrared tubes alone shall be set to an incoming radiant heat flux of 12 kW/m^2, ±4 kW/m^2 (0.3 cal/cm^2/sec, ±0.1 cal/cm^2/sec) using a commercial radiometer meeting the specifications of 6-20.4.2. The radiometer window shall be positioned at the geometric center of the sample holder and at the same plane as the test specimen. The radiometer shall be mounted in a holder of the same overall size, shape, and material as the one used for the copper calorimeter to ensure similar heat and flame patterns across the faces of the radiometer and calorimeters. The radiant quartz tubes shall be turned on and "run" for a minimum of 2 minutes prior to measuring the radiant heat flux.

6-20.5.2.6 The total heat flux shall be set at 83 kW/m^2, ±4 kW/m^2 (2.0 cal/cm^2/sec, ±0.1 cal/cm^2/sec) using the calibration copper calorimeter, defined in 6-20.4.1.10, by adjusting only the gas supply to the Meker or Fisher burners. Without a mounted specimen, the calibration copper calorimeter shall be placed on top of the specimen holder with the blackened copper calorimeter facing down, and then exposed directly to the flame of the burner. The response of the calorimeter shall be recorded for at least 10 seconds. The lowest temperature point on the curve where the response is linear shall be chosen, and the increase in sensor temperature for 10 seconds of heating shall be determined. The initial reading from the 10-second reading shall be subtracted to obtain the increase. The response shall be 148°C, ±3.7°C (267°F, ±6.7°F) equivalent to (7.86, ±0.20 mV for an iron–contantan thermocouple) for an exposure heat flux of 8.3, ±0.2 W/cm^2 (2.0, ±0.05 cal/cm^2/sec).

6-20.5.3 Test Procedure.

6-20.5.3.1 After the total thermal heat flux has been set at 83 kW/m^2, ±4 kW/m^2 (2.0 cal/cm^2/sec, ±0.1 cal/cm^2/sec) using the calibration procedure in 6-20.5.2, the testing copper calorimeter shall be used to measure the total heat flux. Prior to testing, the testing copper calorimeter shall be used to measure the total heat flux by placing the calorimeter facing down and then

exposing it directly to the total heat source. The response of the calorimeter shall be recorded for at least 10 seconds. The lowest temperature point on the curve where the response is linear shall be chosen, and the increase in sensor temperature for 10 seconds of heating shall be determined. The initial reading from the 10-second reading shall be subtracted to obtain the increase. The response shall be 148°C, ±3.7°C (267°F, ±6.7°F) equivalent to (7.86 mV, ±0.20 mV for an iron–contantan thermocouple) for an exposure heat flux of 83 kW/m^2, ±2 kW/m^2 (2.0 cal/cm^2/sec, ±0.05 cal/cm^2/sec).

6-20.5.3.2 If the measurement from the testing copper calorimeter is within +4/−0 kW/m^2 (+0.1/−0 cal/cm^2/sec) then testing shall be done. If the measurement from the testing copper calorimeter does not agree within ±4 kW/m^2 (±0.1 cal/cm^2/sec) of the measurement of the calibration calorimeter, the testing copper calorimeter shall be repaired, reconditioned, or replaced to achieve agreement.

6-20.5.3.3 Specimens shall be mounted by placing the surface of the material to be used as the outside of the garment face down on the mounting plate. The subsequent layers shall be placed on top in the order used in the garment, with the surface to be worn toward the skin facing up. With the protective shutter engaged, the specimens shall be placed on the specimen holder.

6-20.5.3.4 The testing copper calorimeter shall be placed directly on the specimen in contact with the surface to be worn toward the skin.

6-20.5.3.5 The protective shutter shall be retracted and chart paper movement on the recorder shall be started using a chart speed consistent with the preparation of the overlay described in 6-20.5.4.1. The start time of the exposure shall be indicated. The exposure shall be continued for 30 seconds. The protective shutter shall be engaged (closed), the recorder shall be stopped, the calorimeter shall be removed and cooled, then the specimen holder and exposed specimen shall be removed.

6-20.5.3.6 After each exposure, the calorimeter shall be cooled to less than 33°C, ±1°C (90.8°F, ±1.8°F) before the next heat flux determination. The sensor shall be cooled after exposure with a jet of air or by contact with a cold surface.

6-20.5.3.7 The sensor face shall be wiped, while hot, immediately after each run to remove any decomposition products that condense and could be a source of error. If a deposit collects and appears to be thicker than a thin layer of paint, or is irregular, the sensor surface shall be reconditioned. The cooled sensor shall be carefully cleaned with acetone or petroleum solvent in an area where there is no ignition source.

6-20.5.3.7.1* If copper is showing on the testing copper calorimeter, the surface shall be completely repainted with a thin layer of flat black spray paint. At least one calibration run shall be performed comparing the testing copper calorimeter with the calibration copper calorimeter. If the testing calorimeter is in error by more than +4/−0 kW/m^2 (+0.1/−0 cal/cm^2/sec), all electrical connections and points where thermocouples are secured to the testing calorimeter shall be checked. Two more calibration runs shall be conducted by comparing the testing copper calorimeter with the calibration grade copper calorimeter and the average error shall be calculated. If the average error of the testing calorimeter is more than +4 kW/m^2 (+0.1 cal/cm^2/sec), then the testing calorimeter shall be repaired and recalibrated or the testing calorimeter shall be replaced.

6-20.5.4 Preparation of Human Tissue Burn Tolerance.

6-20.5.4.1 Tolerance Overlay. The thermal end point shall be determined with a plot of energy versus the time to cause a second-degree burn in human tissue as shown in Table 6-20.5.4.1. The calorimeter equivalent from Table 6-20.5.4.1 that corresponds to the recorder scale shall be plotted on recorder chart paper. Columns 6, 7, or 8 (ΔT°C, ΔT°F, or ΔmV) shall be plotted on the vertical axis and the corresponding time (Column 1) shall be plotted on the horizontal axis. Chart units based on the recorder full-scale deflection and the chart speed for a graph directly comparable to the recorder sensor trace shall be used. If pen deflection is from left to right and paper movement down, the plot shall be from right to left with origin at lower right. If recorder trace differs, the graph shall be adjusted accordingly. An exact transparent duplicate shall be made for the overlay. The overlay shall be compared with the original to ensure change in the overlay size.

6-20.5.4.2 Computer Processing of the Data. The information provided Table 6-20.5.4.1 shall be permitted to be used as the criteria of performance in the software of a computer program. In this case, the sensor response shall be compared with the thermal response, either pain sensation or second-degree burn in human tissue to determine the thermal end points. The product of the time to a second-degree burn in human tissue and the exposure energy heat flux shall be the TPP rating.

6-20.5.5 Determination of Test Results

6-20.5.5.1 The time to the second-degree burn shall be graphically determined from the recorder chart of the sensor response and criterion overlay prepared in 6-20.5.4.1. The overlay shall be positioned on the recorder chart, matching the zero of the overlay with the first indication of pen deflection resulting from heat transfer. The horizontal axis (time) shall be placed in line with the initial trace of the pen, keeping the overlay square with the recorder chart. The time to the second-degree burn shall be read to the nearest 0.1 second from the overlay chart at the point when the sensor response curve and the tissue tolerance curve cross. If the sensor response curve and the tissue tolerance curves do not cross, "no burn" shall be recorded as the test result.

6-20.5.5.1.1 If a computer software program is used, the sensor response shall be compared with the data describing the human tissue heat tolerance to determine like values. The time from the start of the exposure to the time when these values are the same shall be taken at the exposure time.

Table 6-20.5.4.1 Human Tissue[a] Tolerance to Second-Degree Burn

Exposure	Heat Flux		Total Heat		Calorimeter[b] Equivalent		
Time (s)	cal/cm²s	kW/m²	cal/cm²	kW/m²	ΔT°C	ΔT°F	ΔmV
1	1.2	50	1.20	50	8.9	16.0	0.46
2	0.73	31	1.46	61	10.8	19.5	0.57
3	0.55	23	1.65	69	12.2	22.0	0.63
4	0.45	19	1.80	75	13.3	24.0	0.69
5	0.38	16	1.90	80	14.1	25.3	0.72
6	0.34	14	2.04	85	15.1	27.2	0.78
7	0.30	13	2.10	88	15.5	28.0	0.80
8	0.274	11.5	2.19	92	16.2	29.2	0.83
9	0.252	10.6	2.27	95	16.8	30.2	0.86
10	0.233	9.8	2.33	98	17.3	31.1	0.89
11	0.219	9.2	2.41	101	17.8	32.1	0.92
12	0.205	8.6	2.46	103	18.2	32.8	0.94
13	0.194	8.1	2.52	106	18.7	33.6	0.97
14	0.184	7.7	2.58	108	19.1	34.3	0.99
15	0.177	7.4	2.66	111	19.7	35.4	1.02
16	0.168	7.0	2.69	113	19.8	35.8	1.03
17	0.160	6.7	2.72	114	20.2	36.3	1.04
18	0.154	6.4	2.77	116	20.6	37.0	1.06
19	0.148	6.2	2.81	118	20.8	37.5	1.08
20	0.143	6.0	2.86	120	21.2	38.1	1.10
25	0.122	5.1	3.05	128	22.6	40.7	1.17
30	0.107	4.5	3.21	134	23.8	42.8	1.23

[a]Stoll, A.M., and Chianta, M.A. "Method and Rating System for Evaluation of Thermal Protection," *Aerospace Medicine*, vol. 40, 1968, pp. 1232-1238.
[b]Iron–constantan thermocouple.

6-20.5.5.2 The TPP rating shall be calculated as the product of exposure energy heat flux and time to burn.

$$\text{TPP rating} = F \times T \ (\text{W/sec/cm}^2) \text{ or } (\text{cal/cm}^2)$$

where:

F = exposure heat flux, W/cm (cal/cm²/sec),

and

T = time to burn (sec)

6-20.6 Report.

6-20.6.1 The individual test TPP rating of each specimen shall be reported.

6-20.6.2 The average TPP rating shall be calculated and reported.

6-20.6.3 If a TPP rating is greater than 60, then the TPP rating shall be reported as ">60."

6-20.7 Interpretation.

6-20.7.1 Pass or fail determinations shall be based on the average reported TPP rating of all specimens tested.

6-20.7.2 If an individual result from any test set varies more than ±8 percent from the average result, the results from the test set shall be discarded and another set of specimens shall be tested.

6-21 Flammability Resistance Test.

6-21.1 Application. This test method shall apply to garment materials, visor materials, glove materials, and footwear.

6-21.2 Specimens.

6-21.2.1 Five specimens in each of the warp, machine or coarse, and filling, cross-machine or wale, directions shall be tested.

6-21.2.2 If the material is nonanisotropic, then 10 specimens shall be tested.

6-21.3 Sample Preparation.

6-21.3.1 Specimens shall be conditioned as specified in 6-1.2.

6-21.3.2 Samples for conditioning shall be at least a 1-m (1-yd) square of material.

6-21.4 Procedure. Flame resistance testing shall be conducted in accordance with ASTM F 1358, *Standard Test Method for Resistance of Protective Clothing Materials to Flame Impingement.*

6-21.5 Report.

6-21.5.1 Afterflame times and burn distances results shall be reported for each specimen and as the average for each material direction.

6-21.5.2 The burning behavior observations of each specimen shall be reported.

6-21.6 Interpretation.

6-21.6.1 Failure of the material in any direction shall constitute failing performance.

6-21.6.2 Any specimen exhibiting melting as evidenced by dripping or flowing shall constitute failing performance.

6-22 Static Charge Accumulation Resistance Test.

6-22.1 Application. This test method shall apply to garment and glove materials.

6-22.2 Specimens.

6-22.2.1 A minimum of five specimens, each a 200-mm, ±4 mm (8-in., ± $^{5}/_{32}$ in.) square, shall be cut from the material to be tested.

6-22.2.2 Only the exterior layer of garment or glove material composites shall be tested.

6-22.3 Sample Preparation.

6-22.3.1 Specimens shall be conditioned as specified in 6-1.8.

6-22.3.2 Samples for conditioning shall be of specimen size given in 6-22.2.1.

6-22.4 Apparatus.

6-22.4.1 Triboelectric Test Device. The triboelectric test device shall consist of a grounded aluminum frame with two cutouts in the front faceplate.

The lower right cutout shall house the static detector head that is connected to an electrometer.

The upper left cutout shall be for the rubbing wheel used to generate the triboelectric charge.

This rubbing wheel shall be connected to a $^{1}/_{8}$ horsepower electric drive motor. A manual lever shall be used to slide the motor/rubbing wheel combination forward so that the wheel gently makes contact with the test specimen at the proper time.

The test pressure shall be held constant during the test by means of a weight and cord system. In this system, a cord shall be attached to the motor assembly, shall run over a pulley wheel, and a 1.4 kg, ±0.05 kg (3 lb, ±3 oz) weight shall be attached to the end of the cord.

The test specimen shall be tautly mounted in a grounded specimen holder.

6-22.4.2 Data Gathering System. A digital oscilloscope with memory shall be used for gathering data.

The oscilloscope trigger shall be initiated with a 6-V battery connected to the oscilloscope trigger circuit through a microswitch on the sliding mechanism of the rubbing wheel.

When the rubbing wheel is moved away from the test specimen (thus ceasing charge generation), the microswitch shall initiate the oscilloscope trigger. The detector head shall sense the electrostatic field and the electrometer shall generate a dc voltage proportional to the electrostatic field sensed by the detector head. This voltage shall be fed into the oscilloscope input and shall be displayed on the oscilloscope Y axis versus time. The zero time shall be the time the microswitch circuit triggers the oscilloscope sweep that occurs at the cessation of sample rubbing.

The oscilloscope presentation shall also be permitted to be recorded on an x–y plotter directly connected to the oscilloscope.

The oscilloscope shall also be permitted to have a digital interface to send the data to a digital computer for further analysis and storage.

6-22.4.3 Static Eliminator. A static eliminator that is capable of removing a 25,000-V charge from a 200 mm square by 15 mm (7 in. square by $^{5}/_{8}$ in.) material specimen within 30 seconds shall be used. The static eliminator shall be placed in the test chamber or other testing area.

6-22.5 Procedure.

6-22.5.1 A clean rubbing wheel shall be placed in the test apparatus.

6-22.5.2 The triboelectric test apparatus shall be conditioned in a test environment of 23°C, ±3°C (75°F, ±5°F) and relative humidity of 45 percent, ±5 percent for a minimum of 24 hours.

6-22.5.3 The electrometer and oscilloscope shall be turned on and allowed to warm up for 30 minutes.

6-22.5.4 The test specimen shall be mounted in the sample holder.

6-22.5.5 The test operator shall verify or install the proper weights on the cord. The standard mass shall be 1.36 kg (3 lb).

6-22.5.6 The static eliminator shall be turned on for 30 seconds to remove any residual charge on the test specimen and rubbing wheel.

6-22.5.7 The rubbing wheel motor shall be turned on and the motor shall be adjusted to 200 rpm.

6-22.5.8 The oscilloscope shall be adjusted for the desired display needed.

6-22.5.9 The electrometer shall be zeroed.

6-22.5.10 The sample holder shall be raised and locked into position in front of the rubbing wheel.

6-22.5.11 The control lever shall be moved to initiate rubbing of the test specimen and shall continue rubbing for precisely 10 seconds. During the rubbing, the oscilloscope circuit shall be armed and the electrometer shall be ungrounded.

6-22.5.12 The rubbing wheel shall be retracted and the sample holder shall be permitted to drop in front of the detector head to initiate the measurement of the electrostatic field.

6-22.5.13 The voltage versus time shall be recorded for the peak voltage and at 0.5, 1.0, 2.0, 3.0, 4.0, and 5.0 seconds. Alternatively, the voltages shall be recorded continuously using a data logger for at least 5.0 seconds.

6-22.5.14 The test shall be repeated with a fresh sample each time beginning with 6-22.5.2.

6-22.6 Report. For each specimen, the peak charge generated, the corresponding charge after 5 seconds, and the time required for the charge to reach 10 percent or the maximum charge measured shall be recorded.

6-22.7 Interpretation. The average measured voltage at 5 seconds for each surface tested shall be used individually to determine pass/fail.

Chapter 7 Referenced Publications

7-1 The following documents or portions thereof are referenced within this standard as mandatory requirements and shall be considered part of the requirements of this standard. The edition indicated for each referenced mandatory document is the current edition as of the date of the NFPA issuance of this standard. Some of these mandatory documents might also be referenced in this standard for specific informational purposes and, therefore, are also listed in Appendix B.

7-1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P. O. Box 9101, Quincy, MA 02269-9101.

NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, 1997 edition.

NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus for the Fire Service*, 1997 edition.

NFPA 1991, *Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies*, 2000 edition.

7-1.2 Other Publications.

7-1.2.1 ANSI Publications. American National Standards Institute, Inc., 11 West 42nd Street, 13th floor, New York, NY 10036.

ANSI Z34.1, *Standard for Third-Party Certification Programs for Products, Processes, and Services*, 1993.

ANSI Z41, *Standard for Safety-Toe Footwear*, 1983.

ANSI Z89.1, *Standard for Industrial Head Protection*, 1997.

7-1.2.2 ASTM Publications. American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM D 747, *Standard Test Method for Apparent Bending Modulus of Plastics by Means of a Cantilever Beam*, 1993.

ASTM D 751, *Standard Test Methods for Coated Fabrics*, 1998.

ASTM D 1630, *Standard Test Method for Rubber Property—Abrasion Resistance (NBS Abrader)*, 1994.

ASTM D 2136, *Standard Test Method for Coated Fabrics—Low-Temperature Bend Test*, 1998.

ASTM D 2582, *Standard Test Method for Puncture Propagation Tear Resistance of Plastic Film and Thin Sheeting*, 1993.

ASTM D 4157, *Standard Test Method for Abrasion Resistance of Textile Fabrics (Oscillatory Cylinder Method)*, 1992.

ASTM D 5151, *Standard Test Method for Detection of Holes in Medical Gloves*, 1992.

ASTM F 392, *Standard Test Method for Flex Durability of Flexible Barrier Materials*, 1993.

ASTM F 489, *Standard Test Method for Static Coefficient of Friction of Shoe Sole and Heel Materials as Measured by the James Machine*, 1996.

ASTM F 903, *Standard Test Method for Resistance of Protective Clothing Materials to Penetration by Liquids*, 1996.

ASTM F 1154, *Standard Practices for Qualitatively Evaluating the Comfort, Fit, Function, and Integrity of Chemical Protective Suit Ensembles*, 1996.

ASTM F 1301, *Standard Practice for Labelling Chemical Protective Clothing*, 1996.

ASTM F 1342, *Standard Test Method for Resistance of Protective Clothing Materials to Puncture*, 1996.

ASTM F 1358, *Standard Test Method for Resistance of Protective Clothing Materials to Flame Impingement,* 1995.

ASTM F 1359, *Standard Test Method for Measuring Liquid Penetration Resistance of Protective Clothing or Protective Ensembles Under a Shower Spray While on a Mannequin*, 1997.

ASTM F 1790, *Standard Test Methods for Measuring Cut Resistance of Materials Used in Protective Clothing*, 1997.

7-1.2.3 CSA Publication. Canadian Standards Association, 178 Rexdale Boulevard, Toronto, Canada M9W 1R3.

CSA Standard Z195-M, *Standard for Protective Footwear, Occupational Health and Safety,* 1992.

7-1.2.4 FIA Publication. Footwear Industries of America, 1420 K Street NW, Suite 600, Washington, DC 20005.

FIA Standard 1209, *Whole Shoe Flex*, 1984.

7-1.2.5 GSA Publication. General Services Administration, Specifications Activity, Printed Materials Supply Division, Building 197, Naval Weapons Plant, Washington, DC 20407.

Federal Test Method Standard 191A, *Textile Test Methods*, 1978.

7-1.2.6 ISO Publications. International Standards Organization, 1 rue de Varembé, Case Postale 56, CH-1211 Geneve 20, Switzerland.

ISO Guide 25, *General Requirements for the Competence of Calibration and Testing Laboratories*, 1990.

ISO 9001, *Quality Systems — Model for Quality Assurance in Design, Development, Production, Installation, and Servicing*, 1994.

7-1.2.7 U.S. Government Publication. U.S. Government Printing Office, Superintendent of Documents, Washington, DC 20402.

Title 29, *Code of Federal Regulations*, Part 1910.132.

7-1.2.8 Additional Publications.

Dangerous Properties of Industrial Chemicals, 6th Edition, Sax, N. Irving, 1996.

NIOSH Pocket Guide to Chemical Hazards, U. S. Department of Health and Human Services, Public Health Services, Publication DHHS No. 85-114, September 1996.

Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices, 1996, American Conference of Governmental Industrial Hygienists, 1996.

Appendix A Explanatory Material

Appendix A is not a part of the requirements of this NFPA document but is included for informational purposes only. This appendix contains explanatory material, numbered to correspond with the applicable text paragraphs.

A-1-1.1 The requirements of this standard were developed taking into consideration the needs of emergency response personnel for hazardous materials emergencies. This application can entail a variety of chemical, physical, and other hazards. Other protection needs should warrant a thorough review of the requirements in this standard, such as routine industrial operations to determine their applicability.

There are no requirements in this standard that address reuse or multiple wearings of liquid splash-protective ensembles. Users are cautioned that exposure of liquid splash-protective ensembles to chemicals may require disposal, particularly if the effectiveness of decontamination cannot be assessed.

At the time this standard was prepared, the characteristics of a dust or particulate flash fire have not been defined by this Committee and, therefore, the Committee has chosen not to assume that these exposures are similar to a chemical flash fire nor are the optional additional requirements for chemical flash fire protection adequate as minimum requirements for dust or particulate flash fire protection.

A-1-1.4 Organizations responsible for specialized chemical response functions including radiological, biological, cryogenics, or fire-fighting applications should use protective clothing and equipment specifically designed for those activities.

A-1-2.3 The testing requirements in Chapter 5 of this standard are not intended to establish the limitations of the working environment for hazardous materials emergencies but are intended to establish material performance.

Users should be advised that if unusual conditions prevail, or if there are signs of abuse or mutilation of the protective ensemble or any element or component thereof, or if modifications or replacements are made or accessories are added without authorization of the protective ensemble element manufacturer, the margin of protection might be reduced.

Users should be advised that the protective properties in new liquid splash-protective ensembles, as required by this standard, can diminish as the product is worn and ages.

It is strongly recommended that purchasers of liquid splash-protective ensembles consider the following:

(a) Emergency response personnel must wear many items of protective clothing and equipment. Any interference by one item of another item's use might result in inefficient operations or unsafe situations.

(b) Different breathing apparatus, communications systems, cooling devices, and other protective equipment might not be equally accommodated by each liquid splash-protective suit.

(c) Specification of additional reinforcement in high-wear or load-bearing areas, such as the knees, elbows, shoulders, and back, can be necessary. Reinforcing materials should be the same as the garment material. Purchasers are cautioned that additional weight caused by excessive reinforcement could lead to fatigue or injury to the wearer and change or shorten the life of the garment.

A-1-3.3 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A-1-3.4 Authority Having Jurisdiction. The phrase "authority having jurisdiction" is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A-1-3.12 Chemical Flash Fire. The Technical Committee realized that a policy of wearing protective clothing is needed that recognizes the significant threat to fire fighters who can be exposed to flash fires in either structural fire-fighting or hazardous materials environments. It is hoped that fire fighters utilize awareness training on burn injuries caused by the ignition of the environment. There is a distinct difference between chemical flash fires and flashovers occurring in structural fire-fighting environments.

Flashover is a phenomenon that requires heat and generates temperatures in the range of 650°C to 815°C (1200°F to 1500°F). A chemical flash fire requires an ignition source and a chemical atmosphere that contains a concentration above the lower explosive limit of the chemical. Chemical flash fires generate heat from 540°C to 1040°C (1000°F to 1900°F). A structural fire flashover as a rule is confined to a designated area with walls as a boundary. A chemical flash fire depends on the size of the gas or vapor cloud and when ignited, the flame front expands outward in the form of a fireball. The resulting effect of the fireball's energy with respect to radiant heat significantly enlarges the hazard areas around the gas released.

A-1-3.40 Liquefied Gas. Examples of liquefied gases include ammonia, 1,2-butadiene, chlorine, ethylene oxide, hydrogen chloride, liquefied petroleum gas, and methyl chloride. This is not an inclusive list of liquefied gases.

A-1-3.46 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

A-1-4 Metric units are used throughout this document with approximate U.S. units provided in parentheses. The metric units are the requirements.

A-2-1.1 The compliance of liquid splash-protective ensembles in meeting this standard is determined by the NFPA battery of chemicals. Each liquid splash-protective ensemble, or individual element of a liquid splash-protective ensemble, meeting the requirements of this standard will have a list of chemicals or chemical mixtures associated with it.

Vapor-protective ensembles meeting the requirements of NFPA 1991, *Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies*, provide additional levels of protection not required for protective ensembles compliant with this standard.

A-2-1.8 The National Fire Protection Association (NFPA), from time to time, has received complaints that certain items of fire and emergency services protective clothing or protective equipment might be carrying labels falsely identifying them as compliant with an NFPA standard. The requirement for placing the certification organization's mark on or next to the product label is to help ensure that the purchaser can readily determine compliance of the respective product through independent third-party certification.

A-2-2.1 The certification organization should have a sufficient breadth of interest and activity so that the loss or award of a specific business contract would not be a determining factor in the financial well-being of the agency.

A-2-2.3 The contractual provisions covering a certification program should contain clauses advising the manufacturer that if requirements change, the product should be brought into compliance with the new requirements by a stated effective date through a compliance review program involving all currently listed products.

Without the clauses, certifiers would not be able to move quickly to protect their name, marks, or reputation. A product safety certification program would be deficient without these contractual provisions and the administrative means to back them up.

A-2-2.4 Investigative procedures are important elements of an effective and meaningful product safety certification program. A preliminary review should be carried out on products submitted to the agency before any major testing is undertaken.

A-2-2.7 Such inspections should include, in most instances, witnessing of production tests. With certain products the certification organization inspectors should select samples from the production line and submit them to the main laboratory for countercheck testing. With other products, it may be desirable to purchase samples in the open market for test purposes.

A-2-2.9 For further information and guidance on recall programs, see 21 *CFR* 7, Subpart C.

A-2-3.15 Manufacturers are not limited in their approaches for designing liquid splash-protective ensembles compliant with this standard. If the ensemble design uses combinations of materials or components to meet one part of the standard, then the same combinations must be assessed for all parts of the standard. For example, if a two-part visor is used such that the visor materials meet the chemical resistance requirement, the outer visor cannot be removed to meet the visor clarity requirement. The same configuration must be used for all performance requirements.

A-3-1.1.1 Purchasers might wish to include a requirement in the purchase specifications for an additional label that includes certain information, such as the date of manufacture, manufacturer's name, and garment identification number, to be located in a protected location on the garment so as to reduce the chance of label degradation and as a backup source of information to aid in garment tracking or during an investigation.

A-3-1.1.5 See A-2-1.8.

A-3-1.1.8 Examples of other clothing items that can be required to worn for meeting performance criteria in this standard include, but are not limited to, over garments, over gloves, and over boots. Purchasers must realize that all items specified by the manufacturer and used to determine compliance with this standard, must be worn together. Otherwise, the certification of the garment is voided.

A-3-2 Purchasers and users should be aware that no reliable, nondestructive methods exist to determine the level of contamination for exposed vapor-protective ensembles or their materials. Therefore, users will not be able to determine how effective decontamination methods are in removing chemical contamination from the vapor-protective suit. Vapor-protective ensembles that have received a significant exposure to a chemical or chemical mixture in the estimation of the responsible supervisor should be disposed of.

A-3-3.1 Purchasers should use the technical data package to compare suit performance data when purchasing liquid splash-protective garments. The purchaser should determine the relative ranking of performance data to aid in this selection process.

A-3-3.2 Purchasers should request that all documentation and performance data be provided in a format that will allow easy comparison of products to aid selection.

A-3-3.4 Manufacturers should determine the size range of their ensembles by matching human dimensions with available suit sizes. These determinations should account for other clothing and equipment to be worn by the wearer as recommended by the manufacturer. Assessment of acceptable fit should be determined by using ASTM F 1154, *Standard Practices for Qualitatively Evaluating the Comfort, Fit, Function, and Integrity of Chemical-Protective Suit Ensembles*.

A-6-20.5.2.4 The convergence of the Meker or Fisher burners can be checked using a colored piece of flame-resistant material and operating the burners for a couple of seconds. The pattern of discoloration on the material should appear to be uniform and in the center of the specimen. Any noncircular or nonuniform discoloration should be cause for adjustment of the Meker burners to achieve convergence.

A-6-20.5.3.7.1 *Copper Calorimeter Calibration Procedures.* Calibration of the copper calorimeter is based on the following equation:

$$I = 41.84\left(\frac{MC}{KAE}\right)\left(\frac{dT}{dt}\right)$$

where:

I = incident heat flux, W/cm^2

4.184 = conversion factor to W/cm^2 from cal/cm^2/sec
dT/dt = rate of temperature rise for the calorimeter
(MC/KA) = calorimeter's physical constant that includes the variables A, E, and M

M is the finished mass (g) of the calorimeter, which includes the copper disk and flat black paint mass on the sensing surface minus the thermocouple mass. C is the heat capacity of pure copper, which is 0.0927 cal/g°C. K is the thermocouple conversion constant (0.053 mv/°C) for the Type J, Iron-Constantan thermocouple at an average test temperature of 65°C. A is the surface area (12.49 cm^2) for the calorimeter's front surface, which is exposed to the test heat flux. E is the emissivity or absorptivity of the black paint used on the calorimeter's front surface, usually a value not less than 0.95.

The physical constant used in calibration calculations with these sensors is sensitive to changes in mass and/or emissivity values.

For the copper disk calorimeter used in the TPP test, the punched-out and drilled copper slug mass must be between 17.5 and 18.0 g to meet the temperature rise over 10-second rate requirement.

The calorimeter's physical constant can be calculated based on the above discussion. Check the repaired calorimeter's performance by substituting it with the calibration calorimeter. After proving equivalence, the test calorimeter can be placed back into service.

Copper Calorimeter Repair Procedures. The copper disk can be removed from its support board and checked to ensure that all thermocouple-to-disk connections are secure. Any loose connections should be repaired. To repair loose connections, the thermocouple data transfer wire should be removed, while leaving the short thermocouple wires extending from the sensor's back side. The sensing surface should be smoothed, cleaned, and repainted with a quality flat black paint of known emissivity, with a value of no less than 0.95. It can take two or three light coats to completely and evenly cover the surface. After the paint has thoroughly dried, the finished calorimeter should be carefully weighed, and its total mass recorded to an accuracy of 0.01 g. The total mass should include the copper disk mass with the short thermocouple wires attached and also includes the mass of flat black paint applied to the calorimeter's surface. The calorimeter's finished mass should be determined by subtracting the sensor's thermocouple wire mass from the sensor's total mass. This is accomplished by measuring the sensor's thermocouple wire lengths from their ends down to the calorimeter's back surface. Then the total wire mass should be calculated based on the number of wires and their lengths. This value should then be subtracted from the total mass of the calorimeter assembly to obtain the finished mass. After the finished mass is determined, the data transfer wires should be securely reconnected and the sensor repositioned in its support board.

Appendix B Referenced Publications.

B-1 The following documents or portions thereof are referenced within this standard for informational purposes only and are thus not considered part of the requirements of this standard unless also listed in Chapter 7. The edition indicated here for each reference is the current edition as of the date of the NFPA issuance of this standard.

B-1.1 NFPA Publication. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 1991, *Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies*, 2000 edition.

B-1.2 Other Publications.

B-1.2.1 ASTM Publication. American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM F 1154, *Standard Practices for Qualitatively Evaluating the Comfort, Fit, Function, and Integrity of Chemical-Protective Suit Ensembles*, 1998.

B-1.2.2 U.S. Government Publication. U.S. Government Printing Office, Superintendent of Documents, Washington, DC 20402.

Title 21, *Code of Federal Regulations*, Part 7, Subpart C.

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